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MACHINE DESIGN

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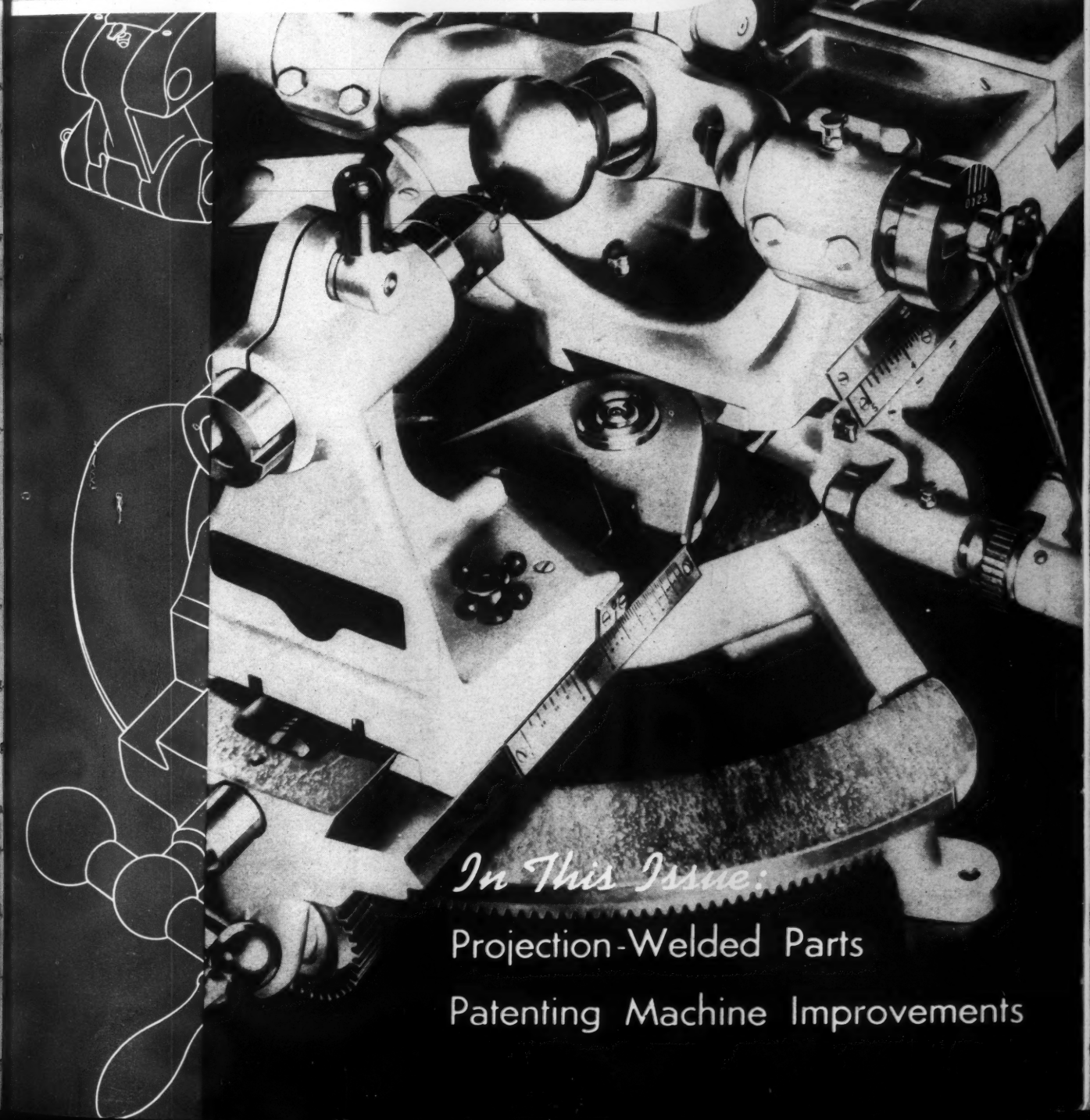

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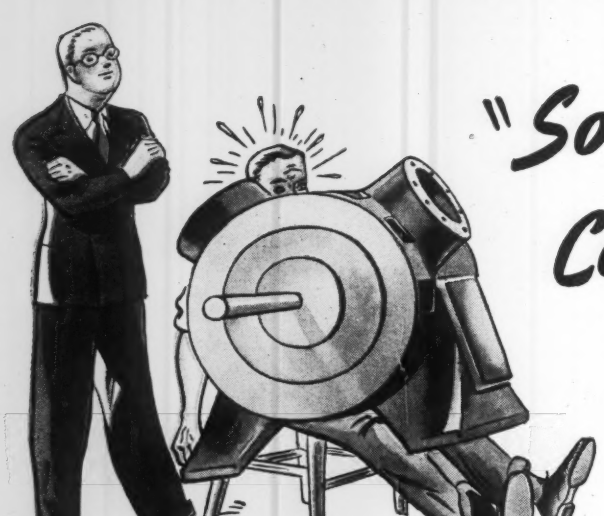
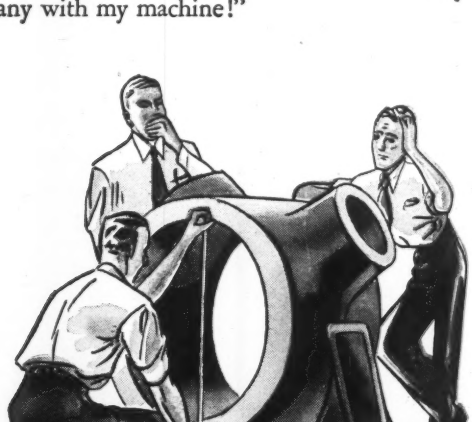
Projection-Welded Parts

Patenting Machine Improvements

"So They Dumped an 1800 lb Compressor in Our Lap!"

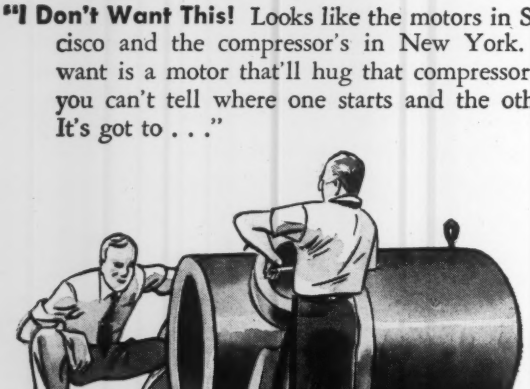


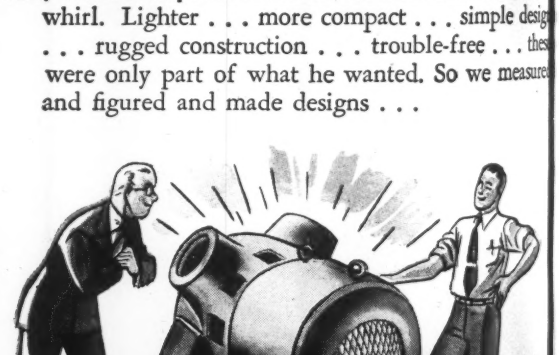
"It's Yours, Old Man," said the Sullivan Machinery Co. to the Allis-Chalmers engineer. "All that compressor needs to make it happy is a motor. But it's got to have the right qualifications before it can keep company with my machine!"



"I Don't Want This! Looks like the motors in San Francisco and the compressor's in New York. What I want is a motor that'll hug that compressor so close you can't tell where one starts and the other ends. It's got to . . ."

Well, That Compressor Manufacturer made our heads whirl. Lighter . . . more compact . . . simple design . . . rugged construction . . . trouble-free . . . these were only part of what he wanted. So we measured and figured and made designs . . .

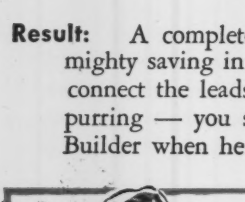




Result: A completely integrated package unit with a mighty saving in space. To install it you only had to connect the leads and it began to purr. Speaking of purring — you should have heard Mr. Compressor Builder when he saw the finished product.

We Cut Overall Size by pressing the rotor on the compressor shaft. That eliminated motor bearings and with it lubrication worries and any chance of misalignment. A new type of housing reduced weight helped pack more hp into less space.

A 192



There's a Moral: Every time Allis-Chalmers engineering solves *special* motor problems, we discover new ways to build better standard motors for you. Watch for these new and better motors from A-C.

Wait 'til you see the NEW ALLIS-CHALMERS MOTORS!

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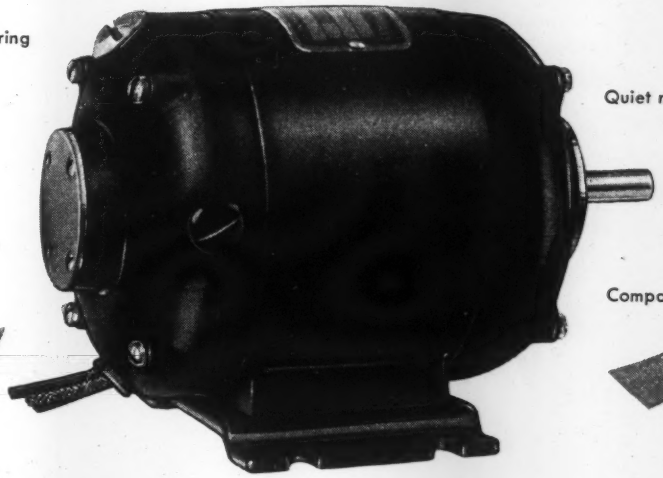

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Machine designers, appliance manufacturers, and instrument makers can profit from Bodine's wide selection of standard fractional horsepower motors when reconverting to civilian production. The Bodine line comprises over 3,000 standard motor frames, sizes, and windings.

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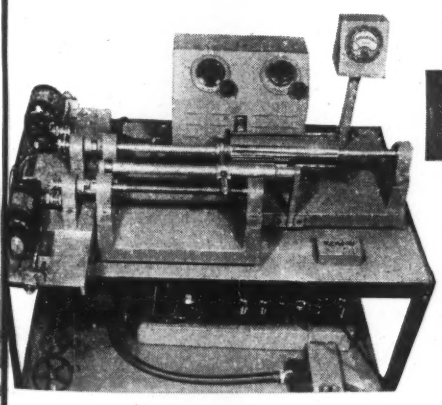
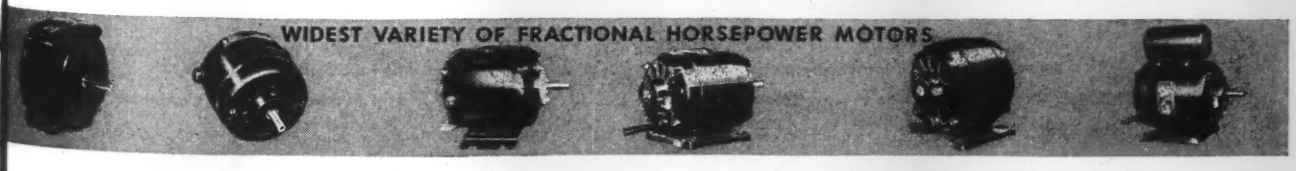


A SIGNAL "SCANNER" THAT TRANSMITS PICTURES

Transmitting pictures by wire or radio is done by a signal "scanner." A photoelectric cell picks up light and dark reflections from the original copy as it is scanned on a revolving cylinder.

The contrasting reflections are transmitted as impulses and are received by a somewhat similar instrument at the receiving station.

For accurate reproduction, the revolving cylinders of both sending and receiving instruments must be perfectly synchronized. The clear reproduction obtained from Alden Standard Signal Scanners is due to the closely synchronized mechanisms driven by Bodine speed reducer motors.



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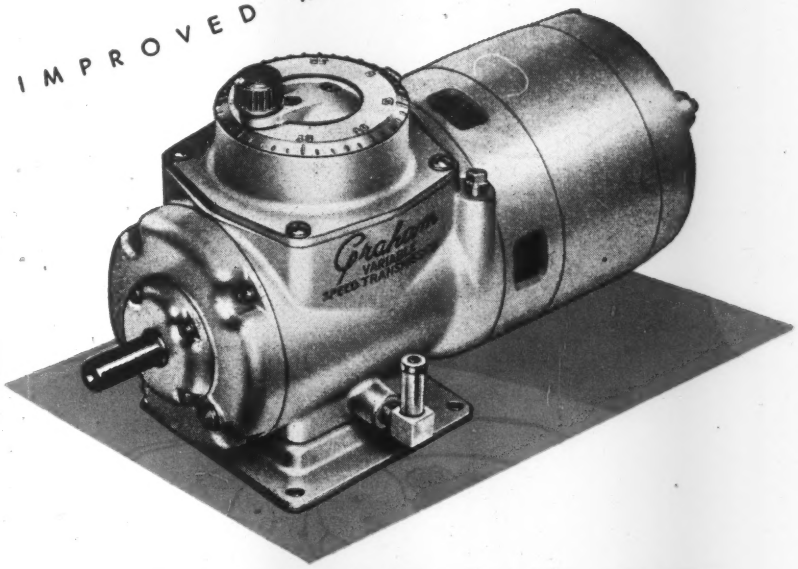

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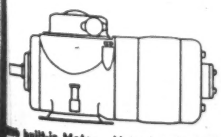
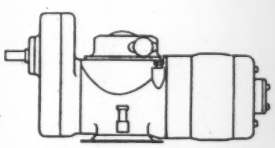
15	3600	1100/0	3.5	7.5	8¼	4⅝	5⅛	1/15 to ⅛
40	3600	1100/0	30	70	19¾	7	8	¼ to ¾
125	1800	650/0	120	240	21	10	13½	1 to 1½

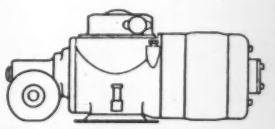


With built-in Motor. Note that the built-in motor is especially designed to form an integral streamlined part of the drive.

15M	3600	1100/0	3.5	7.5	11½	4⅝	5⅛	1/15 to ⅛
40M	3600	1100/0	30	70	19½	7	8	¼ to ¾
125M	1800	650/0	120	240	30	10	13½	1 to 1½



With built-in motor and built-in spur reduction or step-up



With built-in motor and built-in worm reduction. Output shaft may extend horizontally to either side, or vertically up or down. Additional ratios available—6:1, 10:1, 15:1, etc.

Model	Input Speed	Output Speed Range	In. Lbs. Torque Rating: At Max Speed	In. Lbs. Torque Rating: At Min Speed	Approx. Inches Overall Dimensions: Length incl. shaft extension	Approx. Inches Overall Dimensions: Width	Approx. Inches Overall Dimensions: Height	Motor H.P.
15MR5	3600	220/0	15	35	13	4⅝	6¾	1/15 to ⅛
40MR5	3600	220/0	140	320	22	7	10	¼ to ¾
15MS2.5	3600	2750/0	1.3	2.8	13	4⅝	6¾	1/15 to ⅛
40MS2.8	3600	3100/0	11	25	22	7	10	¼ to ¾

15MW20	3600	55/0	35	75	12¾	4⅝	5⅛	1/15 to ⅛
40MW20	3600	55/0	300	700	22	8¾	9	¼ to ¾
125MW20	1800	32/0	1200	2400	34	12½	13½	1 to 1½

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. . . and it looks as if the hungry gentleman above just can't digest that fundamental fact.

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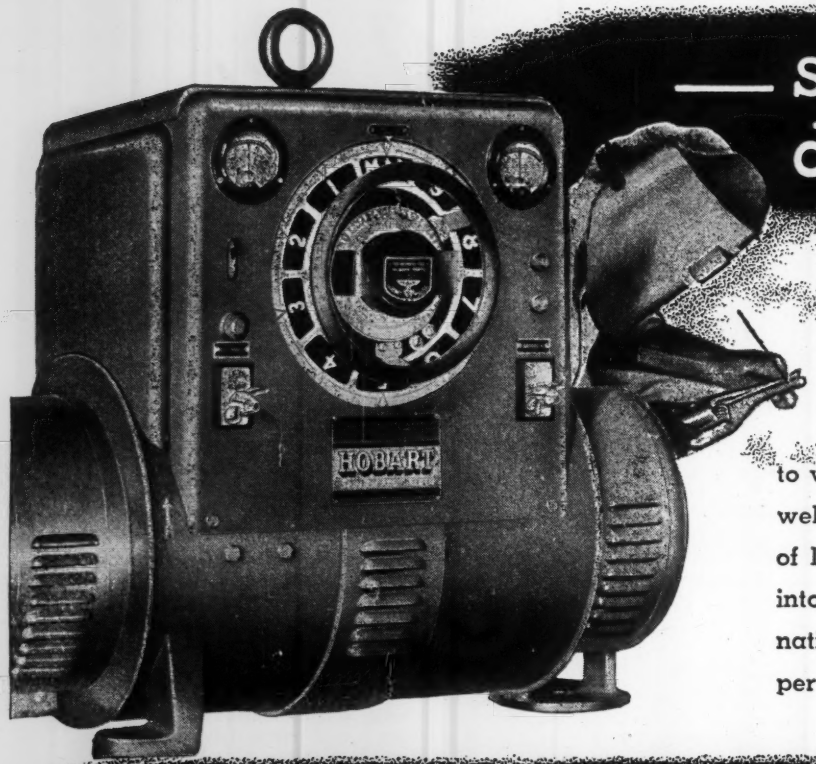

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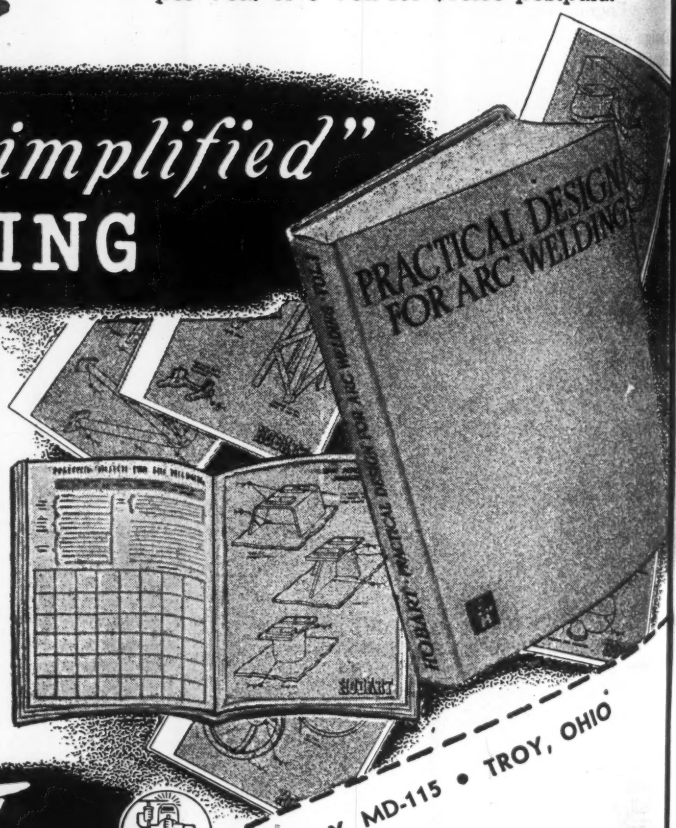

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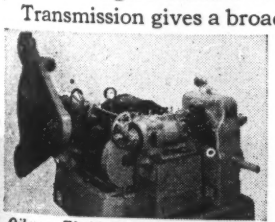
Arc Welder's "Handy Vest Pocket Guide," contains tables, charts, and valuable welding information! Check Coupon!

Oilgear Fluid Power extends range of amazing wire coating machines

The John Royle & Sons tubers are amazing machines that are coating millions of feet of wire with rubber or plastic insulation each week to meet the exacting requirements of the Signal Corps. Previously, not one of these tubers could produce its full capacity; the mechanical transmissions with which they were equipped originally just were not broad enough in their speed range to permit *one* standard tuber to coat *many* different sizes of wire uniformly with the required thickness of rubber or plastic.

But Oilgear Fluid Power could meet that need . . . and did. The Oilgear Transmission gives a broad range of controlled speeds to the capstan and rewind drive of this machine, enabling the latter to handle more sizes of wire and to do a much better job of coating the wire it handles. Similar benefits can be yours . . . if you will investigate the amazing possibilities of Oilgear Fluid Power for your straight line feeds or rotary drives. No matter what your power transmission problem is, you should know what Oilgear can do. THE OILGEAR COMPANY, 1305 W. Bruce St., Milwaukee 4, Wisconsin.



Oilgear Fluid Power enables this John Royle & Sons tubing machine to process many sizes of wire with required thicknesses of coating.

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . . with or without preset time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed of a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full preset automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

OILGEAR Fluid Power

***NITRALLOY—HARDEST STEEL SURFACE KNOWN**

Priorities are off. Nitralloy is available again—in any quantities—to fight wear and fatigue in *civilian* metal products.

The endurance, the *selling features,* that Nitralloy can impart to peacetime machines is indicated in the performance of Nitralloy in war. In army tanks, Nitrided Nitralloy parts operated against each other in sand, moist atmosphere and heat—without lubrication—and *stood up.* Engines with cylinder barrels, reduction gears and other vital parts of Nitralloy carried bombers the equivalent of eight and ten times around the earth, without overhaul.

With an approximate Vickers-Brinell value of 900 to 1100—with its ability to retain hardness at temperatures up to 750° F.—Nitralloy merits the investigation of design engineers for extra life and reliability in bearings, cams, pump parts, shafts, gears . . . any application where wear is a factor.

Nitralloy licensees and warehouses can supply your needs today. For details on how you may apply Nitrided Nitralloy to best advantage, write on your business letterhead for booklets "Nitralloy," "Hardness," "Fatigue of Metals" or "Wear."

THE NITRALLOY CORPORATION
230 PARK AVENUE
NEW YORK 17, N. Y.

Companies Licensed by The Nitralloy Corporation

Allegheny Ludlum Steel Corp.	Watervliet, N. Y.
The Babcock & Wilcox Tube Co.	Beaver Falls, Pa.
Bethlehem Steel Co.	Bethlehem, Pa.
Carnegie-Illinois Steel Corp.	Chicago, Ill.
Copperweld Steel Co.	Warren, O.
Crucible Steel Co. of America	New York, N. Y.
Firth-Sterling Steel Co.	McKeesport, Pa.
Republic Steel Corporation	Cleveland, O.
The Timken Roller Bearing Co.	Canton, O.
Rotary Electric Steel Co.	Detroit, Mich.
Vanadium-Alloys Steel Co.	Pittsburgh, Pa.
Atlas Steel Limited	Welland, Ontario

Operating & Accredited Nitriding Agents

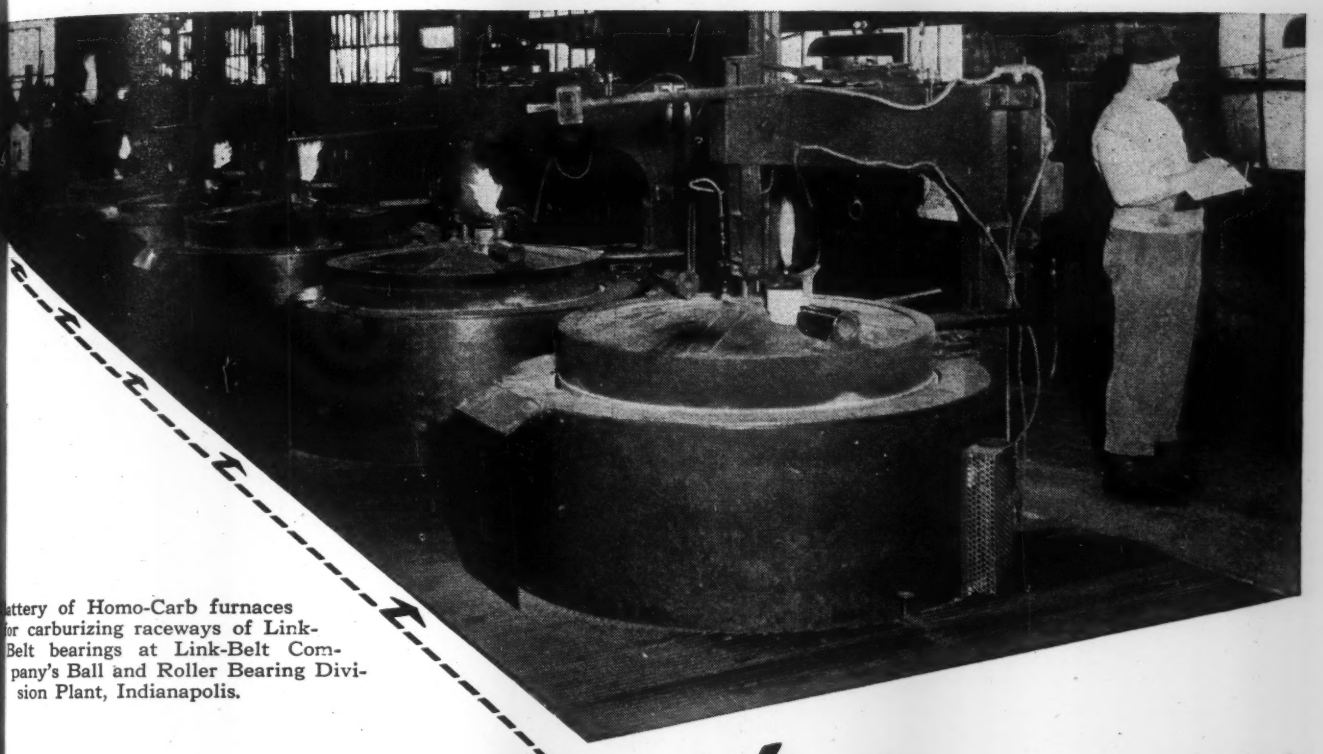
Commercial Steel Treating Corp.	Detroit, Mich.
Englehard & Kenny	North Arlington, N. J.
The Lakeside Steel Improvement Co.	Cleveland, O.
Lindberg Steel Treating Co.	Chicago, Ill.
Link-Belt Co.	Philadelphia, Pa.
Met-Lab, Inc.	Philadelphia, Pa.
New England Metallurgical Corp.	Boston, Mass.
Pittsburgh Commercial Heat Treating Co.	Pittsburgh, Pa.
Queen City Steel Treating Co.	Cincinnati, O.
Rex & Erb	Lansdale, Pa.
The Salkover Metal Processing Co., Inc.	Long Island City, N. Y.
Wesley Steel Treating Co.	Milwaukee, Wis.
N. A. Woodworth Co.	Ferndale, Mich.
Ontario Research Foundation	Toronto, Ontario, Can.

Manufacturers of Nitralloy Steel Castings

Milwaukee Steel Foundry Div., Grede Foundries, Inc.	Milwaukee, Wis.

Warehouse & Stock

A. Milne & Co.	New York, N. Y.
Joseph T. Ryerson & Son, Inc.	Chicago, Ill.
Edgcomb Steel Company	Philadelphia, Pa.



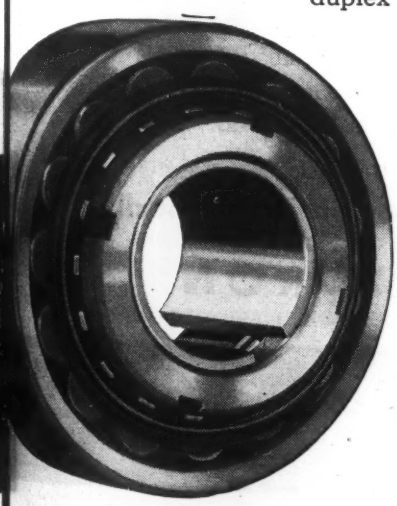
attery of Homo-Carb furnaces for carburizing raceways of Link-Belt bearings at Link-Belt Company's Ball and Roller Bearing Division Plant, Indianapolis.

A Red Hot Start to a Long Life of SERVICE!

● "Right from the start" Link-Belt bearings are the product of the most scientific processes and precision control of every operation. Heat treatment of the raceways and rollers, under modern instrument control gives the toughness and wearability that assure long life, sustained accuracy and free-rolling efficiency.

Right from the start, and *right* at every stage, is the Link-Belt method, which makes the Link-Belt stamp of Quality your assurance of satisfaction.

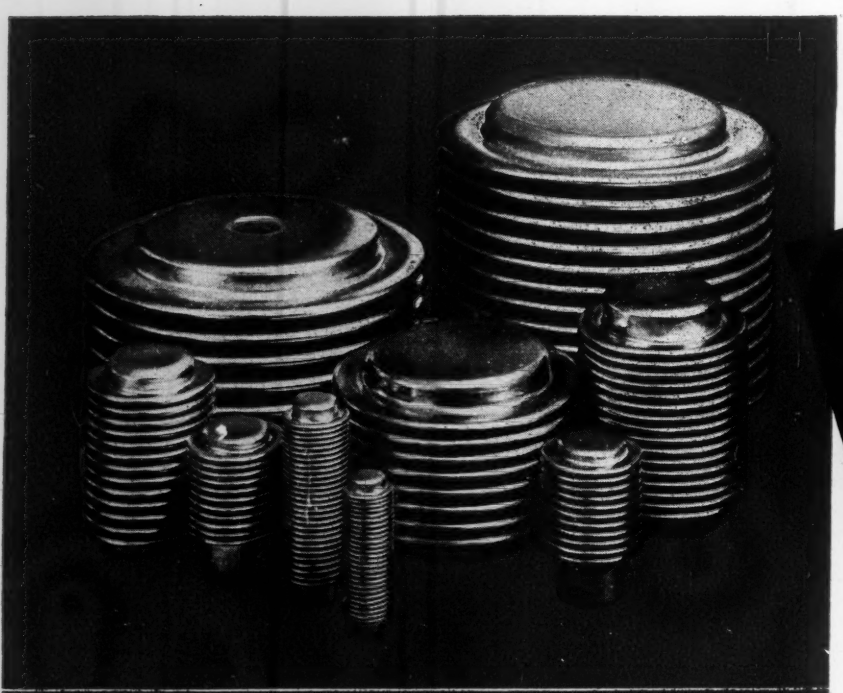
Link-Belt bearings are made without mountings in ball and roller types, and as pillow blocks, and cartridge, flanged, take-up hanger or duplex units. Send for engineering data book No. 1775-A.

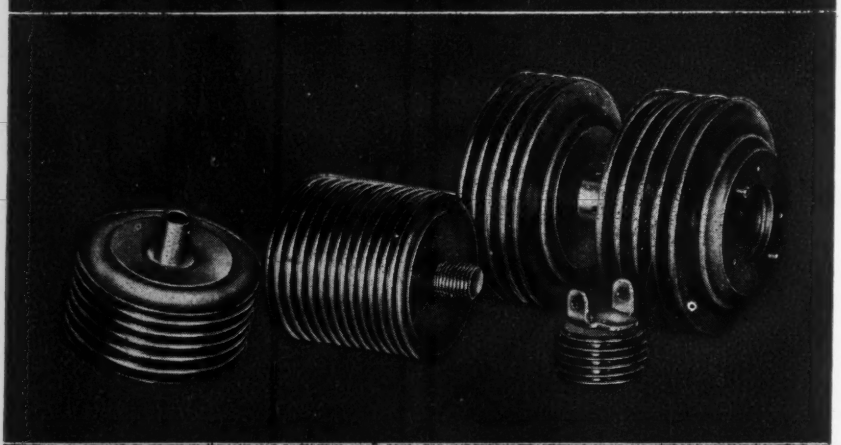


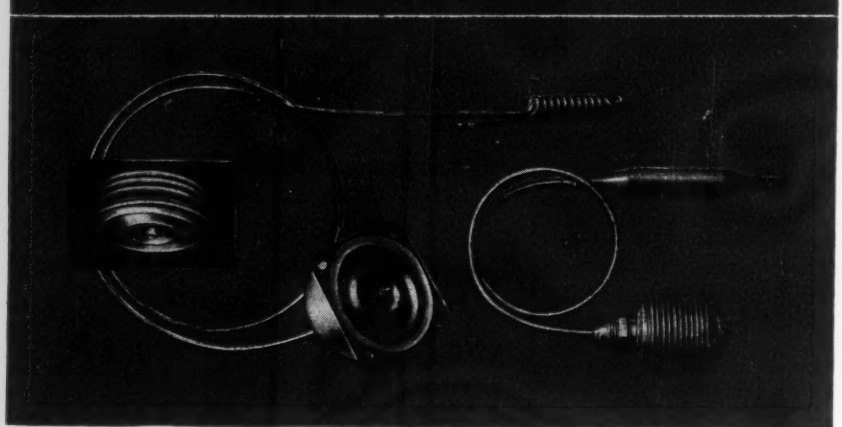
LINK-BELT COMPANY

Builders of the most complete line of power transmission machinery.
Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal cities. 9043

LINK-BELT
BALL AND ROLLER
BEARINGS







FOR MAXIMUM LIFE EXPECTANCY AND SPRING-RATE ACCURACY . . .

. . . specify

CLIFFORD HYDRON BELLOWS AND BELLOWS ASSEMBLIES

Life expectancy and spring rate of bellows depend upon the strength and uniformity of their walls.

Only hydraulically-formed bellows — have walls of pretested strength and absolute uniformity.

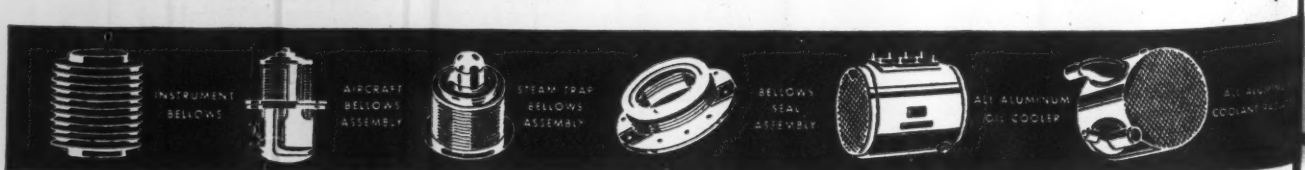
First to produce hydraulically-formed bellows for industry, Clifford has maintained leadership by developing unique metal-working procedures and by designing bellows to meet the most exacting specifications.

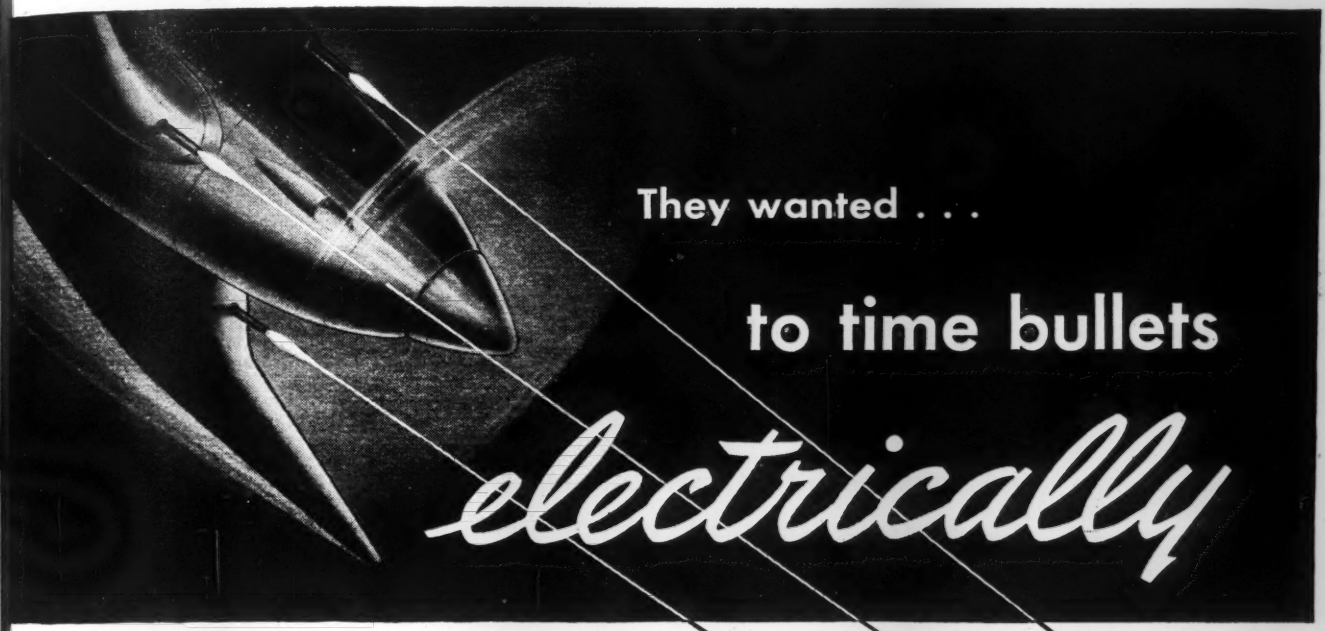
Clifford *specializes* in designing and producing bellows and filled bellows assemblies for industry. Save time, trouble and money by submitting sketches and data before designs are too far advanced. Clifford Manufacturing Company, 566 E. First St., Boston 27, Massachusetts.

CLIFFORD *Feather Weight*

First with the Facts on Hydraulically-Formed Bellows . . . . HYDRON

HYDRON





They wanted . . . to time bullets *electrically*

The engineers of Fairchild Camera & Instrument Corporation had an idea!

Why not design a compact, electrically-controlled machine gun synchronizer to overcome the drawbacks of bulky, complex mechanical types?

Then, there'd be no limit on the number of guns that could be fired through the prop. The rate of fire could be kept up regardless of how fast or slow the engine was working. Fire power could be concentrated in a more devastating pattern than is possible with guns strung along the wings. And, adjusting time could be reduced from hours to minutes.

But after electrical and mechanical details had been worked out, one big question threatened its practicability. *Was there a metal with all the properties needed for the most vital part?*

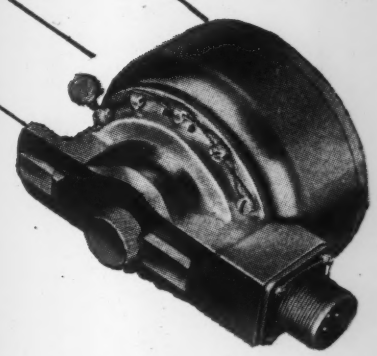
That part was the trigger-motor armature. It had to be small, lightweight (2¼ oz.)—yet tough enough to exert a 55-lb. punch *and take* a 110-lb. recoil 72 times a second . . . It had to be heat-treatable to Rockwell C 38—*yet* machinable and ductile enough to permit cold-working . . . It had to be non-magnetic for operation in an electric circuit . . . It had to resist fatigue, warpage, and corrosion in jungle heat or stratosphere cold.

Quite a large order for *one* metal to fill. But production went ahead, for such a metal *was* available..."KR" MONEL.

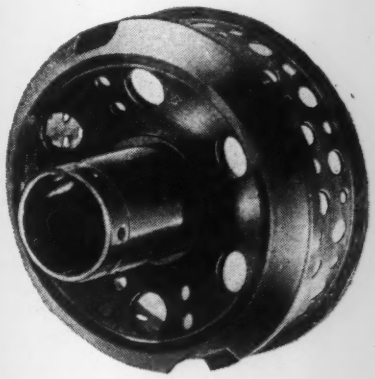
* * * *

Heat-treatable, machinable "KR" MONEL is one of the problem-solving INCO Nickel Alloys—a family of strong, tough, heat- and corrosion-resistant metals. They're all described in "Tremendous Trifles." May we mail you a copy?

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N. Y.



TRIGGER MOTOR *of the Fairchild Electric Synchronizer. Mounts on side plate of the gun, and provides constant fire power at any engine speed between 900-1440 rpm. Total weight only 9 pounds.*



TRIGGER-MOTOR ARMATURE *(Close-up view) of the Fairchild Electric Synchronizer. Machined from "KR" MONEL bar stock. Walls are only 0.013" thick. The thirty pairs of holes are punched out in one minute. Weighs only 2¼ ounces without windings.*

NICKEL INCO TRADE MARK **ALLOYS**

"K" MONEL* • "S" MONEL* • "R" MONEL* • "KR" MONEL* • INCONEL* • "Z" NICKEL* • NICKEL • Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)

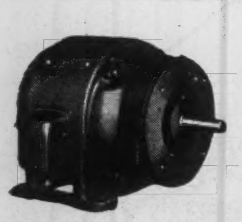
* Reg. U. S. Pat. Off.

Designer's

JUST BOLT THE MOTOR TO THE MACHINE

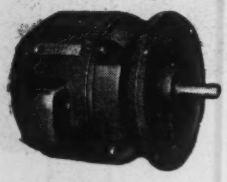
(or vice versa)

G-E motors like these simplify your design job, save space, and cut your assembly costs



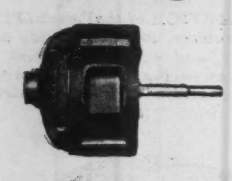
FACE-TYPE MOTORS

Use them where the motor supports the machine. Mounting bolts are screwed into tapped holes in the machined end shield of the motor. The line includes ratings from 1/20 to 50 hp in squirrel-cage type, 1/4 to 50 hp in wound-rotor type, from 1/20 to 10 hp in single-phase type and d-c motors from 1/20 to 60 hp. Tri-Clad type shown has foot mounting. Also available without feet.



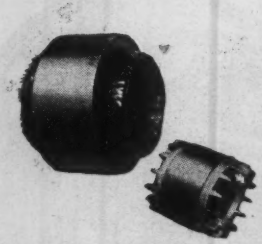
FLANGE-TYPE MOTORS

For use where the machine supports the motor. The flanged end shield of the motor is secured to the machine with through bolts. Available in same range of sizes and types as face-type with or without feet. Type B flange has NEMA standardized dimensions.



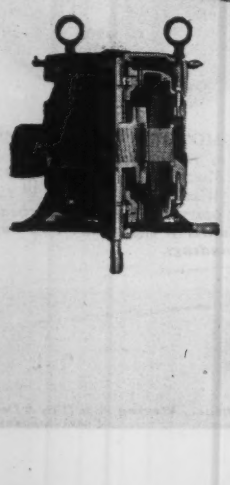
PARTIAL MOTORS

This type is either closely coupled to the driven machine or built right in. Usually furnished as a complete motor less one or both end shields, or less shaft, for applications where the machine can substitute for one or both end shields. Ratings are the same as in complete motors.



SHELL-TYPE MOTORS

Used where a high-speed motor must be built right into the machine or where a smooth, streamlined motor with close shaft or bearing centers is required. The motor consists of shaftless rotor and a shell-like frame to carry stator punchings and windings. Speeds up to 3600 rpm at 60 cycles are available — higher speeds can be furnished for operation on higher frequencies.



VERTICAL MOTORS

For direct coupling to vertical machine shafts. Five base types are available — ring, face, tripod, end-shield mounting, and NEMA Type B flange. Ratings range from ½ to several thousand horsepower in squirrel-cage, wound-rotor, synchronous, single-phase and d-c type motors.

Direct-coupled motors that literally become a part of your product not only save space and make for better appearance, but they can also be great time savers on the assembly line.

The G-E modified standard motors shown here have precision-machined end-shield surfaces and rabbets. All dimensions (and the angular relation of shaft to end-shield face) are held to close tolerances. This means that you get accurate, lasting alignment without fussy adjustments. In fact, you just bolt the motor to the machine and your product is ready to go.

MACHINE DESIGN IS STREAMLINED

In bringing your motor-drive problems to G. E. you save design time two ways. You save time because G. E. offers the most complete line of standard motor types and enclosures. Chances are that you can pick a motor with exactly the mechanical construction and torque and speed characteristics you want *right out of the catalog*. You save time on knotty motor problems, too, because G. E. can put an unparalleled background of motor-application experience to work on your specific problem. A call to our nearest office will start the ball rolling. Further details in Bulletin GEA-4092.

Keep on buying BONDS — *and keep all you buy*

GENERAL ELECTRIC

Digest

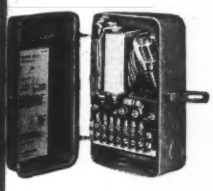
TIMELY HIGHLIGHTS ON G-E PRODUCTS

Automatic Pilot

for processing machines

G-E time switches on processing machines are like extra men on a payroll. The user merely sets the time — the switch automatically goes into action at the second specified. This cycle timer accurately controls a series of operations from 10 seconds up to 1 hour in length. It repeats ON and OFF operations at any interval selected within its range. Use it for timing mixing machines, exhaust fans, pumps, blowers, filters, and similar machines. Details are in Bulletin GEA-2963.

New, Small



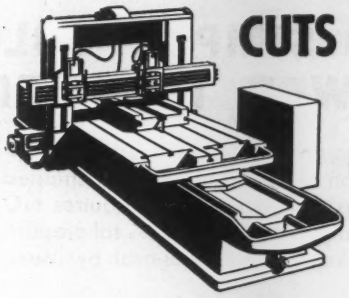
electronic relay

Because it is able to amplify very limited currents transmitted by delicate control contacts or high-resistance circuits, this new G-E relay can greatly increase the use range of many control devices. Small in size, light in weight, and easily installed, it can be operated by any contact-making medium having a resistance up to 500,000 ohms (this can be increased to 5 million ohms if desired). It's especially suitable for liquid-level control, sorting metal parts for size, textile seam detection, and for service requiring a sensitive limit switch. Bulletin GEA-4214.

New Ballasts

for the lamps of tomorrow

G. E. announces two new ballasts for fluorescent lamps. The first is a disk-shaped unit with a center mounting hole for use with 12-inch Circline fluorescent lamps. It can be assembled on portable lamp stems — concealed in the lamp base — or adapted to shallow-type wall or ceiling fixtures. The second new ballast is a high-voltage type for operating the new Slimline Mazda F lamps without any separate starting equipment. Available for lamp current values of 100 or 200 milliamperes. Ask for Supplements 2 and 3 to Bulletin GEA-3293F.



CUTS ROUND TRIP TIME on all kinds of cuts

A G-E adjustable-voltage drive on your planer gives the machine greater speed and versatility than other types of drive. It accelerates and decelerates the table quickly yet smoothly, and permits it to be reversed many times per minute. Thus, the planer table makes very fast round trips, and the user often can produce an extra unit of work per shift.

Moreover, your planer is able to take on a wide variety of jobs, because the operator can select the best cutting speed for a particular metal and still get an extremely fast return speed. The table responds promptly to a limit switch, thereby permitting accurate planing up to shoulders and in pockets. Planer operation is also greatly simplified. Control is centralized in a single push-button station and a single rheostat enclosure. The drive is easy to install and is built to withstand severe operating conditions with little maintenance.

Why not discuss the G-E planer drive soon with one of our application engineers? Complete details are in Bulletin GEA-3785A.

TO GENERAL ELECTRIC COMPANY
Apparatus Dept., Section C668-45
Schenectady 5, N. Y.

Please send me the following Bulletin (s):

GEA-4092, G-E motors _____
GEA-2963, Time meters _____
GEA-4214, Electronic relays _____
GEA-3293F, Lamp ballasts _____
GEA-3785A, Planer drives _____

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Company _____
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City _____ State _____

8579

TRADE

MAXITORQ

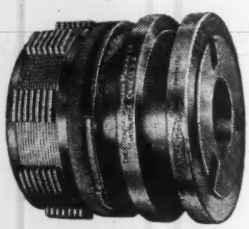
MARK

Floating Disc CLUTCHES

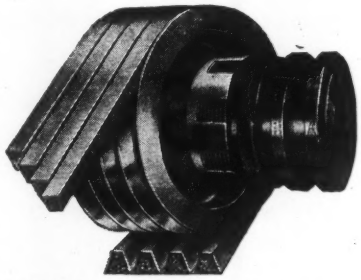
For SIMPLE SOLUTION OF *modern* POWER TRANSMISSION PROBLEMS

Here is the clutch you have long wanted . . . completely assembled on the clutch body and shipped to you ready to slip onto a shaft. It requires NO TOOLS for assembly, adjustment or take-apart. Floating Discs are kept apart in neutral by Maxitorq Separator Springs (patented) so that you can see light between them. Disengagement is fast and positive. Check the clutches shown below . . . one or several will best solve your transmission problems.

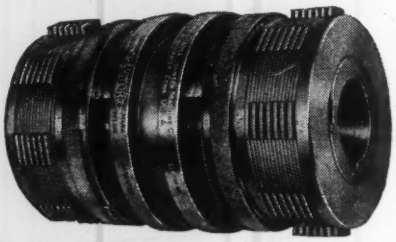
Floating discs . . . NO DRAG . . . NO ABRASION . . . NO HEATING *in neutral*



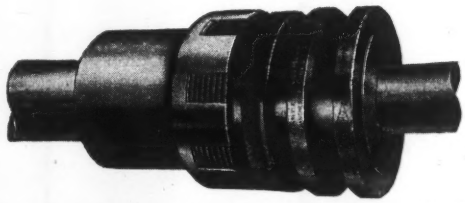
SINGLE TYPE CLUTCH used for intermittent power transmission. Widely adaptable to machine head stocks, gear boxes and V-belt, flat belt, chain drive or spur gear installations between shafting. Also in a special design, as an automatic OVERLOAD RELEASING safety device.



PULLEY TYPE CLUTCH all Maxitorq clutches are available in V-Belt or Spur Gear Type for use on a shaft. Pulley, etc. mounted on the loose sleeve of clutch, body is keyed to shaft. Driving pulley can be immediately released or connected with the shaft.



DOUBLE TYPE CLUTCH now more frequently used as a machine control for reversing motions such as tapping attachments, feed movements of automatic machinery and for reversing main spindles in machine tools. Also as a high and low speed, or one end as a quick acting positive brake.

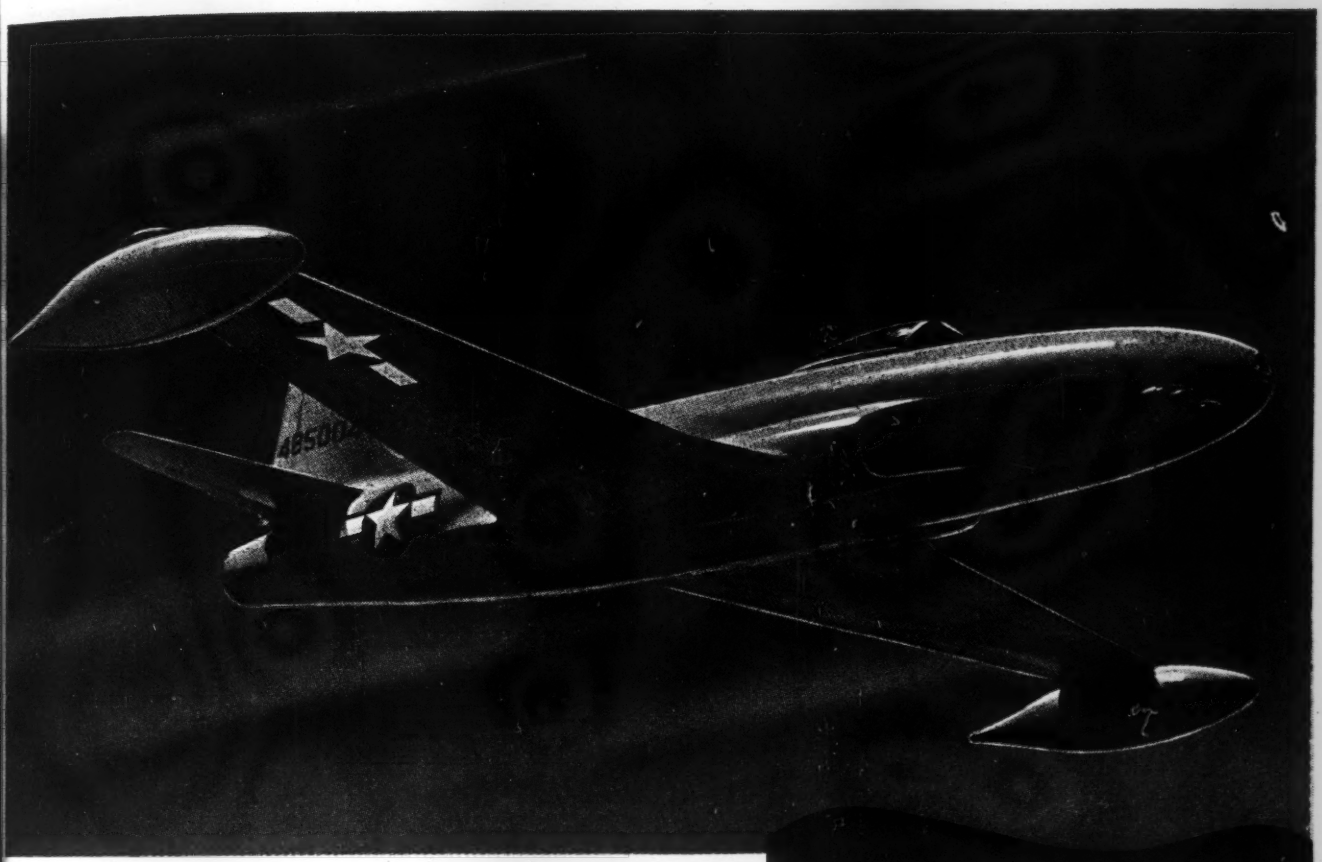


CUT-OFF COUPLING CLUTCH is used as a one-way cut-off coupling (single type) where motors are direct connected to machines they drive . . . motor shaft permanently keyed to one part of clutch . . . driving shaft of machine keyed to the other.

SPECIAL APPLICATIONS: Carlyle Johnson Engineers will be glad to provide assistance for the solution of power control problems, with recommendations for the best applications of Maxitorq clutches. Do not hesitate to ask for this service.

New Catalog No. MD 11 . . . Now Available on Request

THE CARLYLE JOHNSON MACHINE COMPANY · MANCHESTER, CONNECTICUT



Blades for Breathing

Quantity Production Jet Turbine Blades Solved by Microcast Process

Flying higher and faster than ever before possible, jet propelled aircraft such as the Lockheed Shooting Star P-80 "breathe" vast quantities of air—supplied by turbine-driven compressors.

In designing blades for these turbines it was necessary to use high melting point, extremely hard alloys such as *Vitallium, capable of withstanding the tremendous force and heat of jet blasts. High melting point alloys being difficult and expensive to machine were a problem in quantity production. The answer—MICROCAST, the process of precision casting high melting point non-machineable alloys which has proven so successful in producing specialty blades by the millions for gasoline aircraft turbo-superchargers.

COPYRIGHT 1945 BY AUSTENAL LABORATORIES, INC.

The MICROCAST Process is foremost in the precision casting of specialty blades for power development units. Engineers are finding that MICROCAST, by permitting the economical quantity production of high melting point alloy castings, has opened the way to many design improvements particularly where extreme resistance to wear and stress is required.

*VITALLIUM
A non-machineable alloy

MICROCAST

The precision process originated by Austenal Laboratories, Inc., for the production of castings of intricate design where accurate dimensions and surface smoothness are absolutely essential. Small castings produced by Microcast Process require little or no machining. Consider Microcast in your product plans.

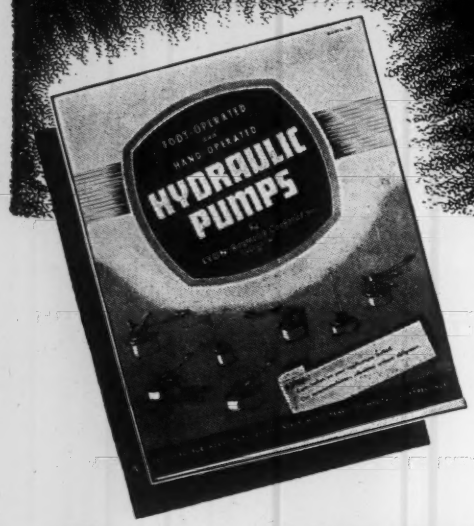
AUSTENAL LABORATORIES, INC.

224 East 39th Street, New York 16, New York
5932 South Wentworth Avenue, Chicago 21, Illinois

FREE Bulletin

IS READY....

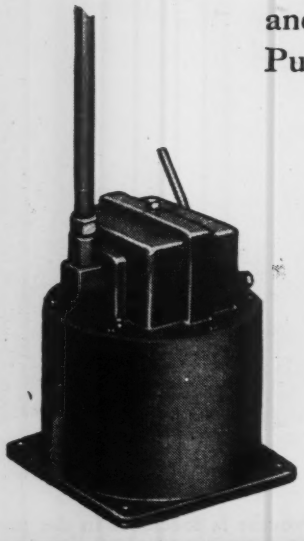
Write for it Today



New High Efficiency HYDRAULIC PUMPS *by* LYON-Raymond...

You'll want our new Hydraulic Pump bulletin for your design reference. It includes types, sizes, capacities, engineering data, and specifications. You ought to know more about the Hydraulic Pumps that offer *all* these features:

- ★ HIGHER EFFICIENCY
- ★ PRESSURES UP TO 10,000 Lbs. per Sq. In.
- ★ LARGE OIL VOLUME PER STROKE
- ★ SINGLE OR 2-SPEED
- ★ TROUBLE FREE OPERATION
- ★ HAND OR FOOT OPERATED



LYON-Raymond Also Manufactures
Hydraulically Operated

Lift Trucks
Pallet Lift Trucks
High Lift Trucks
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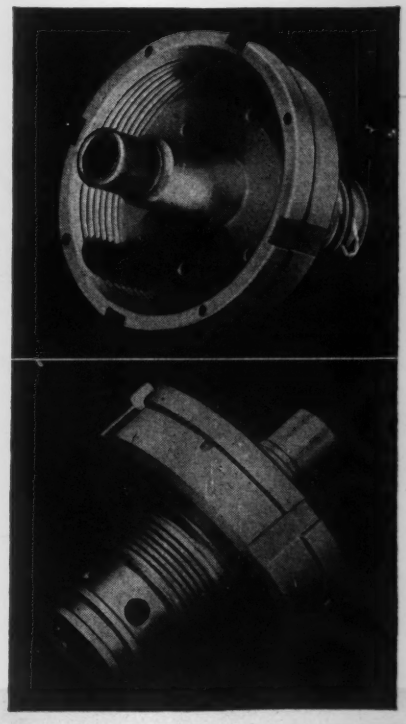
Die and Sheet Handling Equipment
Die Testing Presses
Elevating Platforms — Stationary Type
Engineered Hydraulic Devices

Ask for Bulletin 138

LYON-Raymond Corp.
458 MADISON ST. GREENE, N. Y.
Material Handling Equipment

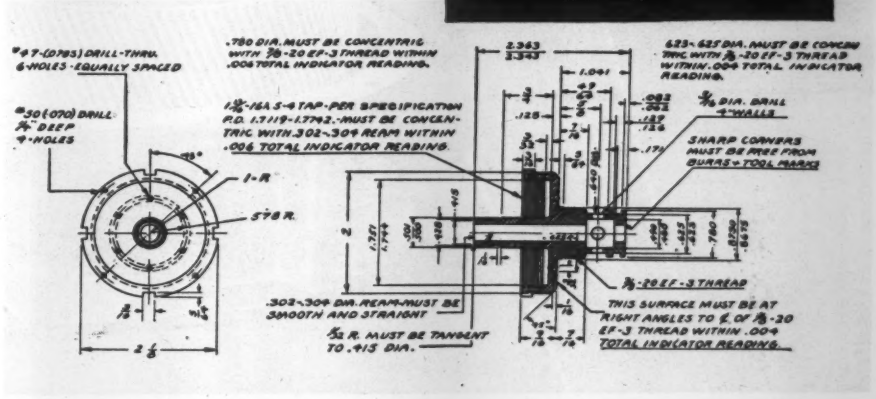
Scovill FORGINGS

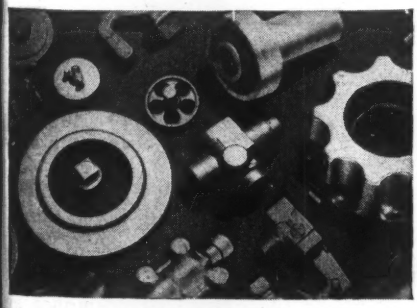


When SCOVILL becomes your METAL-PARTner . . .

You Can Stop Worrying About Machined Forgings like this

This is a brass part for an airplane carburetor—*forged and machined by Scovill.* Notice where the specifications call for the .500-501 dimension, the Class 4 tapped thread, the Class 3 thread, the surface at right angles to the Class 3 thread within .004 total indicator reading. This is just a sample of the kind of forging and machining work that is routine in Scovill's Forgings Division.





Your metal parts may be more complicated than our sample . . . may be of different metals . . . may require closer or permit wider tolerances. But, whatever your specifications, Scovill's long experience in tackling and licking tough forging jobs in nonferrous metals *plus* Scovill's extensive metal machining facilities may be your best bet for saving time, trouble and money.

WRITE FOR MORE FACTS. To learn whether it will pay you to make us *your* METAL-PARTner, fill in coupon below and mail it today. Scovill Manufacturing Company, Waterbury 91, Conn.

SCOVILL
Masters of Metal

Please send me information about your metal-working facilities. I am interested in metal forgings for the applications checked:

- ☐ Aircraft
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- ☐ Industrial Instruments
- ☐ Plumbing Goods
- ☐ Pumps
- ☐ Valves
- ☐ Welding Equipment

Other applications.....

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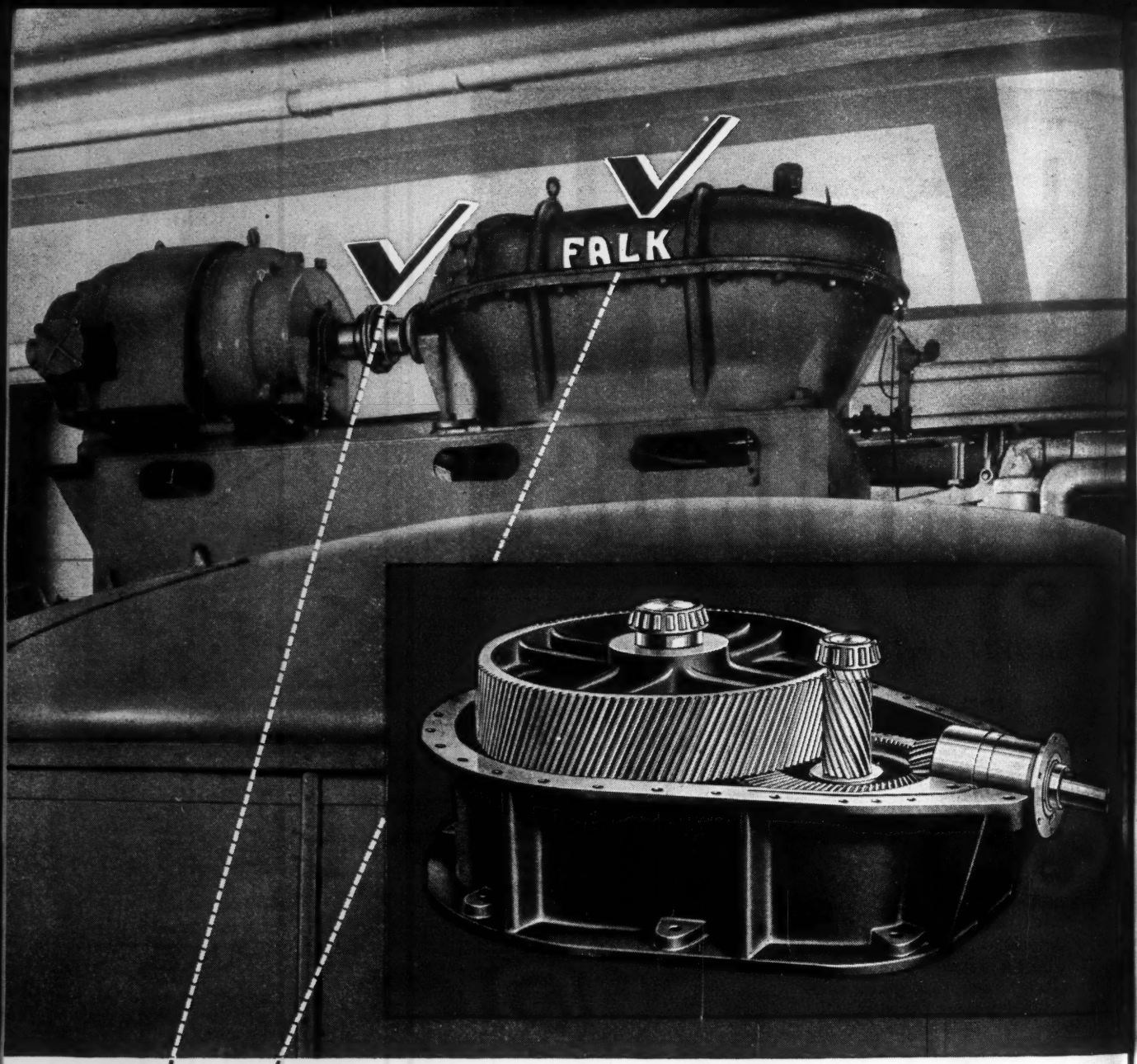
SCOVILL MANUFACTURING COMPANY
Forgings Division
19 Mill Street
Waterbury 91, Connecticut

Name .....

Company .....

Address .....



This illustration shows a Falk Vertical Right Angle Speed Reducer and a Falk Steelflex Coupling as the power transmitting units operating an agitator drive in a large nationally known brewery. This combination of a Falk Steelflex Coupling and a Falk Speed Reducer is typical of many such installations throughout every industrial field.

Proof by Performance is the Best Proof of Worth

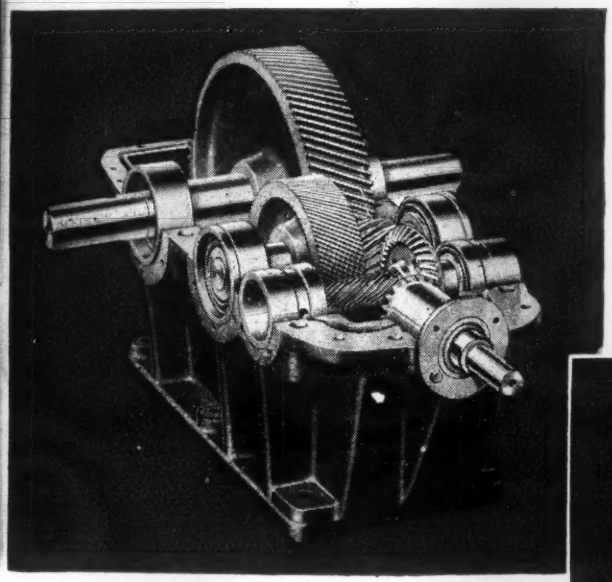
Words at their best can carry only a suggestion of the worth of a product... The final proof of worth—the best proof—is proof by actual performance in the field.

The field performance of Falk Speed Reducers reflects the unusual skills acquired by Falk engineers during their long years of experience in the manufacture of herringbone and single helical gears, and special high speed drives.

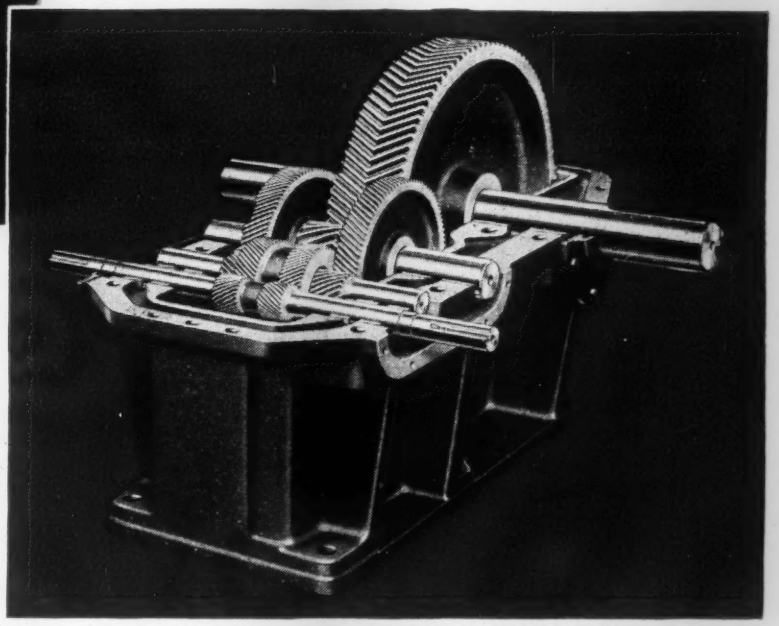
Case histories of Falk Speed Reducer performance in many segments of industry show continuous high efficiency, and extremely long life.

IT ALWAYS PAYS TO CONSULT FALK

Any Size... Any Service Requirement can be fully met with Falk Speed Reducers



Falk Speed Reducers are available in single, double, and triple reduction; in parallel shaft, horizontal right angle and vertical right angle types; in ranges from 0.13 H.P. to 2000 H.P.; in ratios from 1.5:1 to 5.28:1 to 52:1 to 515:1 . . . Available with either sleeve or roller bearings . . . All Falk Speed Reducers have a 100% excess capacity and peak efficiencies from 96% to 98½% depending upon the reduction . . . Symmetrical arrangement assures balanced performance . . . Patented system of lubrication and interchangeability of parts assure long life.



Left: Right angle Falk Speed Reducer with vertical low speed shaft. Available in single reduction units, 1.5:1 to 5.28:1; double reduction, 5.7:1 to 43.5:1; triple reduction, 52.1:1 to 430:1.

Above: Right angle speed reducer. Available in single reduction units, 1.15:1 to 5.28:1; double reduction, 5.7:1 to 52.1:1; triple reduction, 56:1 to 515:1.

Right: Parallel shaft, herringbone speed reducer. Ratios: single reduction, 1.5:1 to 10:1; double reduction, 11.5:1 to 70.2:1; triple reduction, 80:1 to 300:1.

THE FALK CORPORATION, MILWAUKEE 8 WISCONSIN

For over fifty years precision manufacturers of Speed Reducers . . . Motoreducers . . . Flexible Couplings . . . Herringbone and Single Helical Gears . . . Heavy Gear Drives . . . Marine Turbine and Diesel Gear Drives and Clutches . . . Contract Welding and Machine Work • District Offices, Representatives, or Distributors in principal cities.

FALK . . . A GOOD NAME IN INDUSTRY

We make no standard type motors BUT . . . if you have a special powering problem, we will design and build a motor to meet those special requirements.

Hundreds of machine manufacturers know from experience that there is no machine powering problem too difficult for us to solve. The thousands of custom-built Welco Torque Motors rendering low cost, dependable service throughout the country today are the finest proof possible of the unique and outstanding engineering "know-how" of The B. A. Wesche Electric Company.

The special motor that others can't or won't build poses a particular challenge to us. In our thirty-five years of custom-built motor experience, we have successfully solved every powering problem placed before us. Because it is a matter of pride with us to keep that record perfect, you can depend on us to build the functionally correct motor to meet your special powering needs.

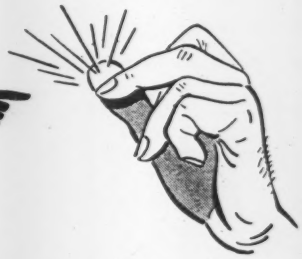
EXCLUSIVE FEATURE

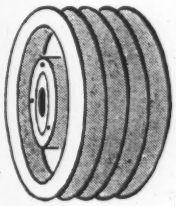
The "Uni-frame" construction of WELCO Torque Motors provides for an easy interchange of A.C. and D.C. motors to fit the same housing or frame. Only WELCO has this vitally important feature.

Write today for complete details

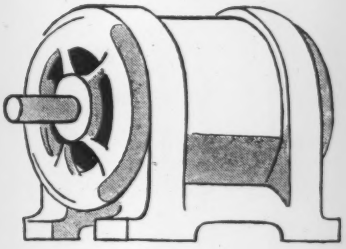
THE B. A. WESCHE ELECTRIC COMPANY
1622-6 VINE STREET **CINCINNATI, OHIO**

Just like this



this  goes

on or off this



Yes, it's a snap to change sheaves now, when you provide Allis-Chalmers' new "Magic-Grip" — *fastest mounting and demounting sheave on the market.* Saves time and money.

SEE WHY THE NEW "MAGIC-GRIP" MOUNTS FAST, PERFORMS SMOOTHLY

1 Place sheave on shaft. Slides on smoothly because clearance is provided by expanded bushing. There's *no* hammering — *no* forcing! Complete sheave and bushing unit comes intact—ready for quick, easy mounting.

2 Align exactly, using straightedge, (It's easy with this free-sliding sheave.) Then tighten three cap-screws; sheave is locked to shaft, *grips like magic!* No set screws to damage the shaft. Write A-C for Bulletin B6310.

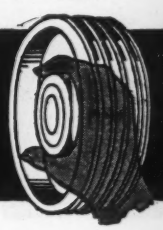
RECONVERTING?

GET THIS NEW FREE KIT!

To help you find out how your present equipment will fit into future production, A-C offers a new free "Reconversion Inventory Kit" — Fact Sheets and Check Lists to speed your appraisal of V-belt drives, electric motors, and centrifugal pumps. Applies to all makes. Call your A-C distributor or district office, or write Dept. 57, ALLIS-CHALMERS MFG., Milwaukee 1, Wisconsin.

A 1857

Allis-Chalmers Texrope

"MAGIC-GRIP"  SHEAVES

21 JEWEL ENGINE

Like a fine watch, the Allison engine has a "21-jewel movement"—assuring dependability and long life. The jewels are the major silver-plated and copper-lead cast sleeve-type bearings, which absorb terrific loads and high temperatures from shafts revolving 3,000 times a minute. ★ Twenty years ago, Allison engineers pioneered the development of higher-precision sleeve-type bearings to enable engines to develop higher horsepower. Today, installed in virtually every aircraft engine made in this country—as well as Allison—these bearings have made good—at horsepowers far beyond the dreams of the Allison pioneers. ★ Now Allison bearings are available for other fine engines and machines to serve a world at peace.

KEEP AMERICA STRONG
BUY VICTORY BONDS

POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51A—Mustang
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Approximately 70,000 Allison engines have been built for the above planes of the U. S. Army Air Forces.

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF GM GENERAL MOTORS

Indianapolis, Indiana

Every Sunday Afternoon—GENERAL MOTORS SYMPHONY OF THE AIR—*NBC Network*

CHECK THESE AND OTHER FEATURES OF GEARS BY

FRACTIONAL HORSEPOWER GEARING

If small gears are involved in your postwar plans, remember *it's a job for G-S!* Here, gears from 12 to 96 d.p. are a highly developed specialty. We've produced them in large quantities for many of America's biggest users for a quarter century, or more. G-S methods and machinery have been raised to a degree of speed and efficiency unapproached in the history of fine small gear manufacture. Discuss your problems with our engineers. Write or wire today. Get suggestions, ideas, and cost estimates. No obligation, of course.

DON'T WAIT! . . PRODUCTION FOR POST-WAR CIVILIAN PRODUCTS IS BEING SCHEDULED NOW!

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GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

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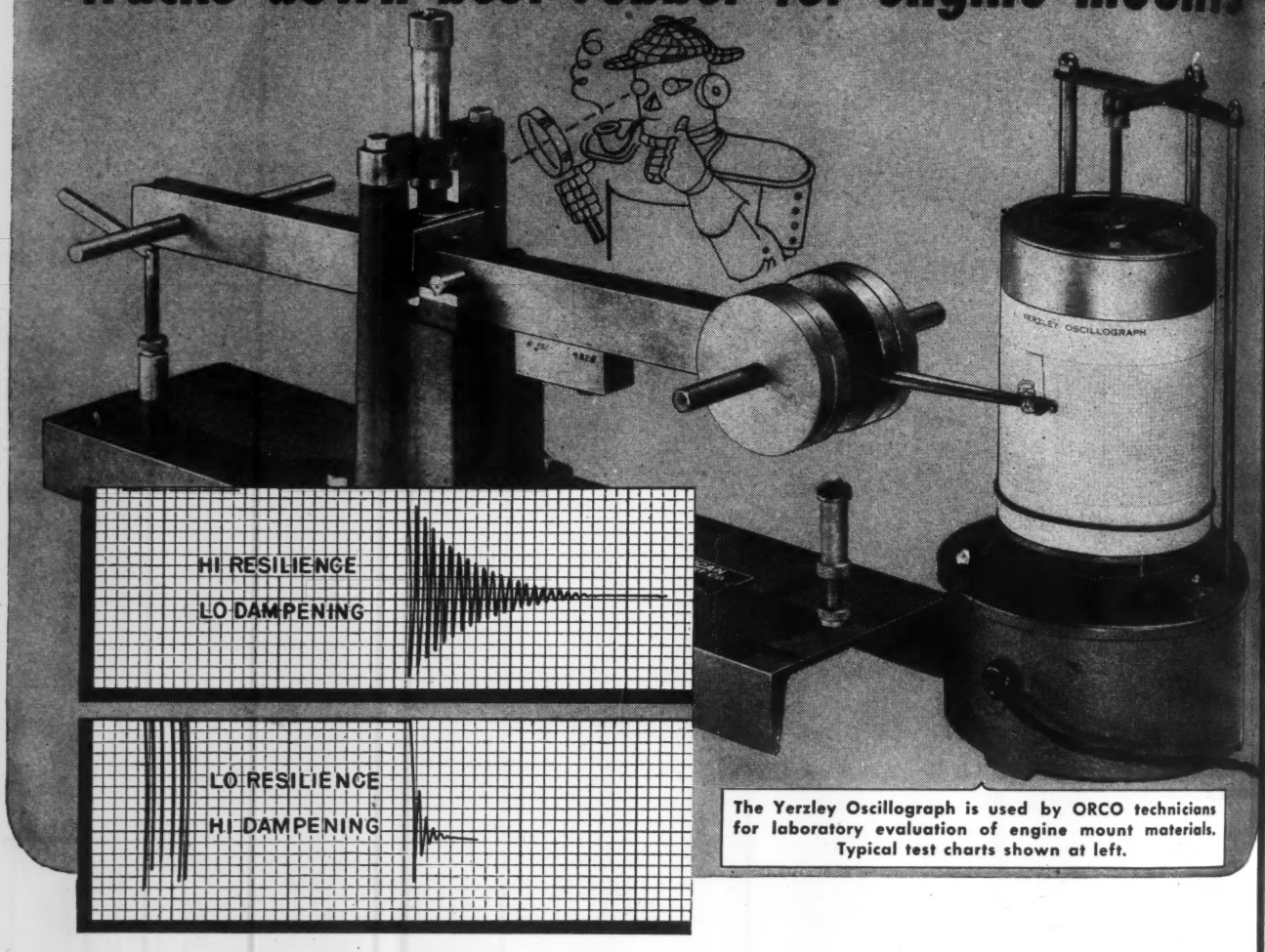
WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Mechanical Detective

tracks down best rubber for engine mounts



The Yerzley Oscillograph is used by ORCO technicians for laboratory evaluation of engine mount materials. Typical test charts shown at left.

SHOCK and VIBRATION continue to be "Engine Enemies No. 1." But greater control of these "enemies" is made possible by a "mechanical detective" known as the Oscillograph.

Function of the Oscillograph is to "track down" the elusive characteristics of rubber and rubber-like materials compounded for engine mount specifications.

Resilience measurements under both static and dynamic conditions are made with the Oscillograph. Determining the characteristics of engine mount materials narrows down to a finer degree of accuracy. The search for the best compound to meet a given combination of conditions becomes almost a routine procedure.

The Oscillograph is an example of the numerous types of modern equipment employed by ORCO technicians to meet exacting specifications for mechanical molded and extruded rubber and synthetic rubber parts and products for diversified industries.

When YOU face a problem in rubber . . . CALL "ORCO."

"ORCO-OPERATION"

BRANCHES: DETROIT • NEW YORK • CHICAGO
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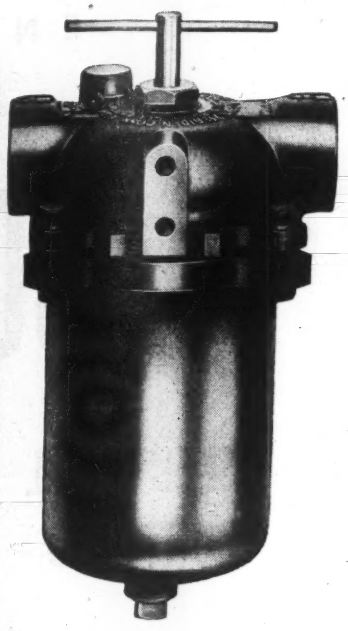
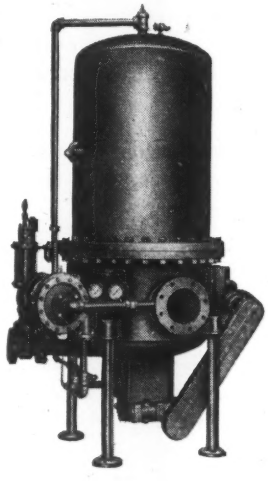
THE OHIO RUBBER COMPANY · WILLOUGHBY, OHIO



AUTO-KLEAN disc-type. For all fluids except those containing highly abrasive solids. Viscosities from 30 to 50,000 Saybolt Seconds. Sizes from 1¼" diam. x ⅞" cartridges to massive motor-driven models. With variety of built-in types.



FLO-KLEAN wire-wound. For fluids containing highly abrasive solids such as metal chips, abrasive wheel particles, sand, etc. Low pressure drop — fluid moves in straight line, encountering only momentary restriction. Constructions to meet varying corrosive and erosive conditions.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

CLEANING THE FILTER WON'T STALL THE FLUID

"Continuously-cleanable" is a big reason why both machine builders and production men prefer the Cuno filter

Machine builders appreciate the *compactness* of the Cuno — possible because the continuously-cleanable feature means no duplex installation is required for full flow. The Cuno filter occupies no more space than the usual partial-flow type.

Production men like the *uninterrupted flow*. Cleaning the filter is done while the filter is still working. Turning a handle (by hand or by motor) cleans the Auto-Klean; a motor-driven backwash system cleans the Flo-Klean. Nothing, in either case, to remove or renew.

The Cuno catalog in SWEET'S tells where to use Auto-Klean, where to use Flo-Klean (the latter generally in cases where the fluid-borne particles are highly abrasive). Positive cleaning action is effective down to .0025" size . . . minimum pressure drop . . . permanent, all-metal filter elements — in both cases.

Apply direct to Cuno for complete catalog (use coupon) or for the recommendation of the Cuno engineering staff.

CUNO ENGINEERING CORPORATION
211 South Vine Street, Meriden, Conn.

Please send me a free copy of your new catalog. I am especially interested in the services checked.

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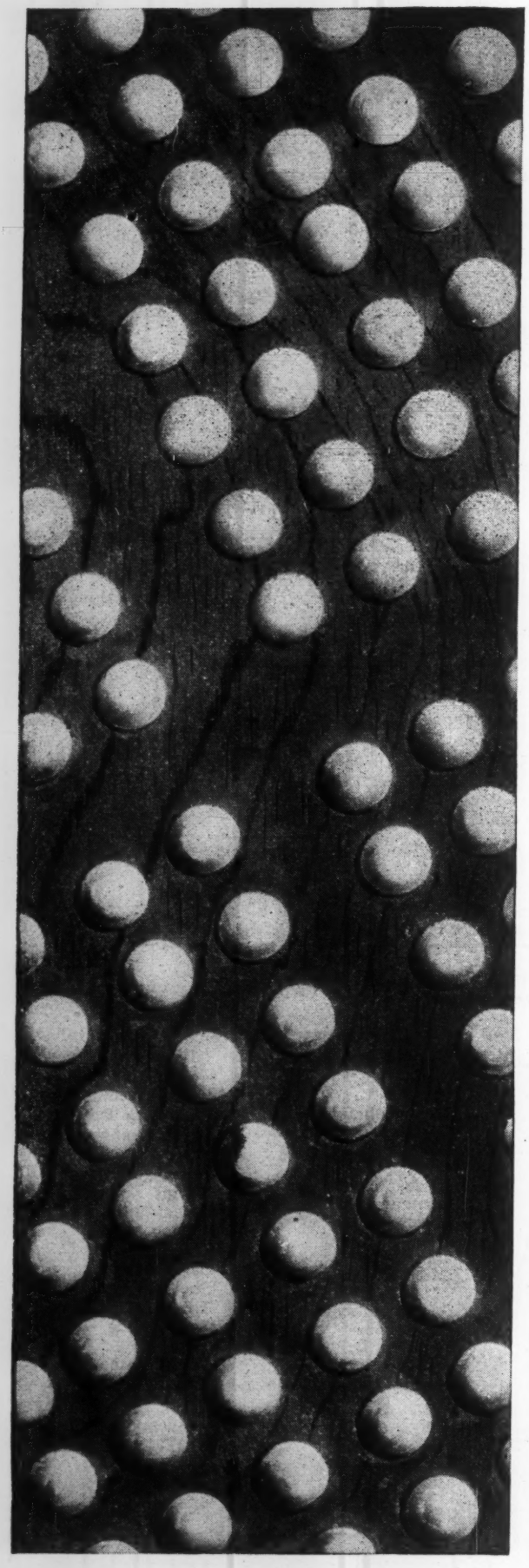

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PROPERTIES AND CHARACTERISTICS:—WILCO AERO NO. 50 ALLOY CONTACTS are composed entirely of noble metals, and are especially desirable for higher frequency operations because of their extreme hardness, high melting and boiling points, freedom from contact surface oxidation, low contact resistance and high density. They are therefore extensively used in Tirrell type vibrating voltage regulators, in aircraft, warship and tank voltage regulators, meter-testing devices, dental and medical equipment, thermal cutouts, electric heaters, time switches, and many other severe-service applications.

WILCO AERO No. 50 ALLOY and other Platinum Contacts are available in a variety of shapes, solid rivets, or as parts of screw, blade or other assemblies.

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SEND FOR WILCO BLUE BOOK—The Blue Book contains charts, formulae, and full descriptions of *all* Electrical Contacts, including WILCO AERO No. 50 Alloy, and other WILCO products. Send for FREE copy today.

WILCO PRODUCTS INCLUDE:

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THERMOSTATIC BIMETAL—
All Temperature ranges, deflection rates and electrical resistivities.

PRECIOUS METAL COLLECTOR RINGS—
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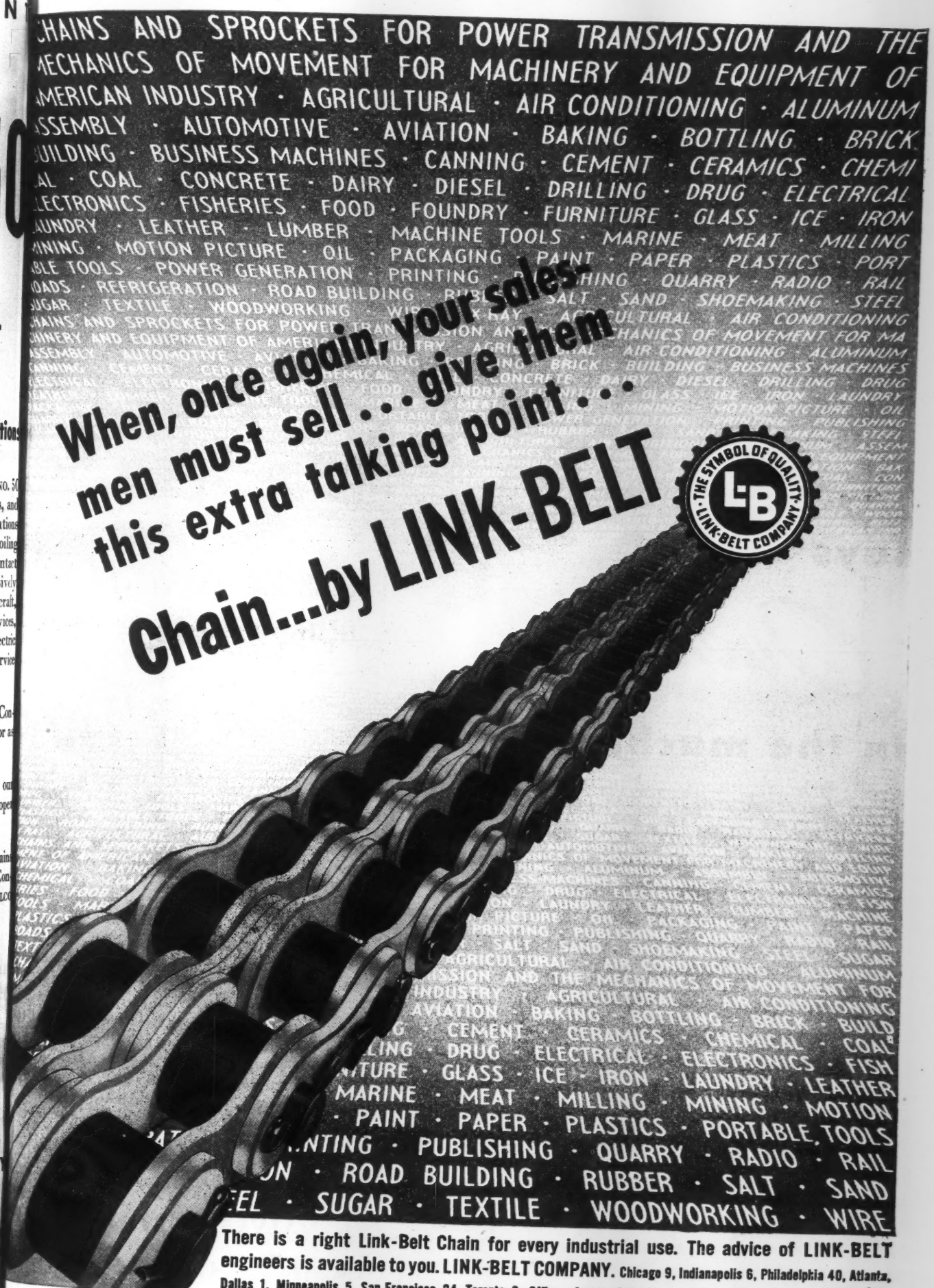
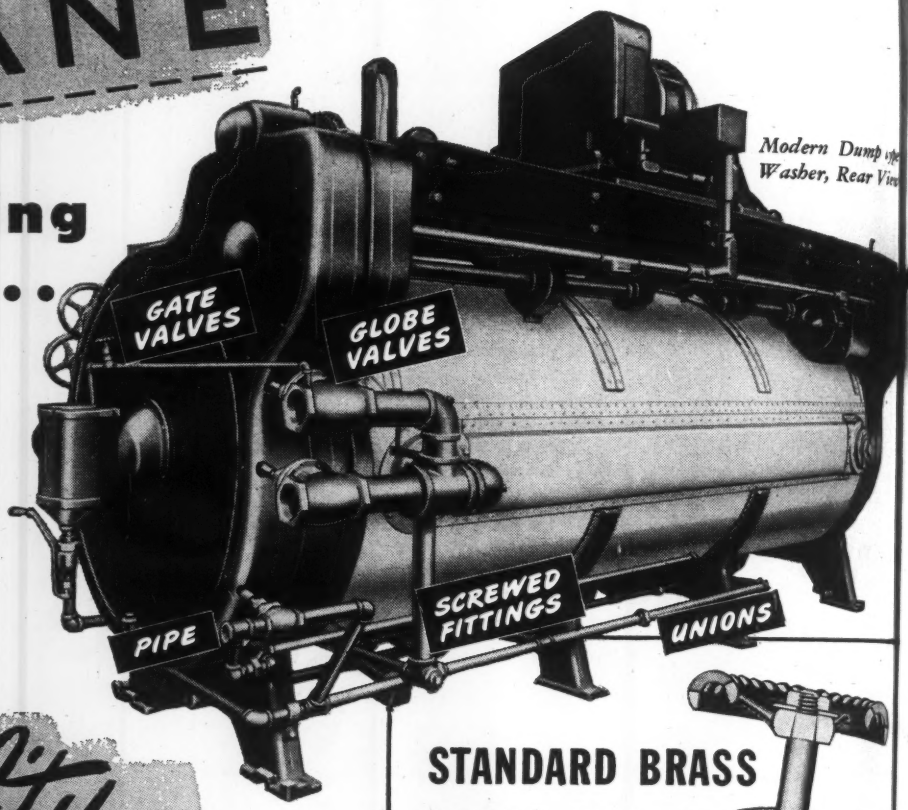


There is a right Link-Belt Chain for every industrial use. The advice of LINK-BELT engineers is available to you. LINK-BELT COMPANY. Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Toronto 8. Offices, factory branch stores and distributors in principal cities.

CRANE

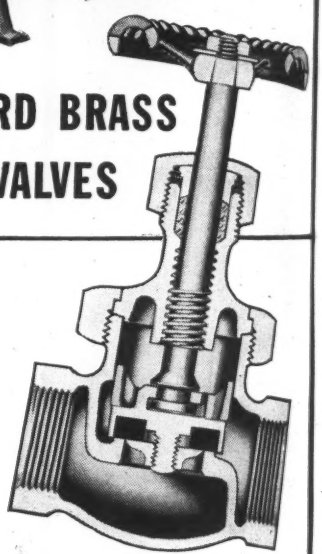
on the piping materials...



Modern Dump type Washer, Rear View

says *Quality* in the machine

STANDARD BRASS GLOBE VALVES



• Your design bears an added stamp of quality when Crane piping materials are used—and equipment buyers know it! Crane Co.'s 90-year experience in quality piping equipment insures satisfaction for both you and your customer. That's only one advantage you get when you specify from the world's greatest line of valves, fittings and piping specialties—in brass, iron and steel—in all sizes and patterns. You save precious time because you specify from a single source of supply. There is undivided responsibility behind all piping materials. You'll find the solution to any problem regarding piping materials—when you depend on the Crane line.

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ONE RESPONSIBILITY **ONE SOURCE OF SUPPLY**

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Crane 150-Pound Composition Disc Brass Globe Valves are available with proper discs which make them suitable for steam, hot water, cold water, oil, air, or gas service. Screwed end valves are recommended for working pressures up to 150 pounds steam; 300 pounds cold. Flanged end valves, up to 150 pounds steam; 225 pounds cold. Made in both globe and angle patterns in sizes from ⅛ to 3 in. Listed on page 30 of your Crane Catalog.

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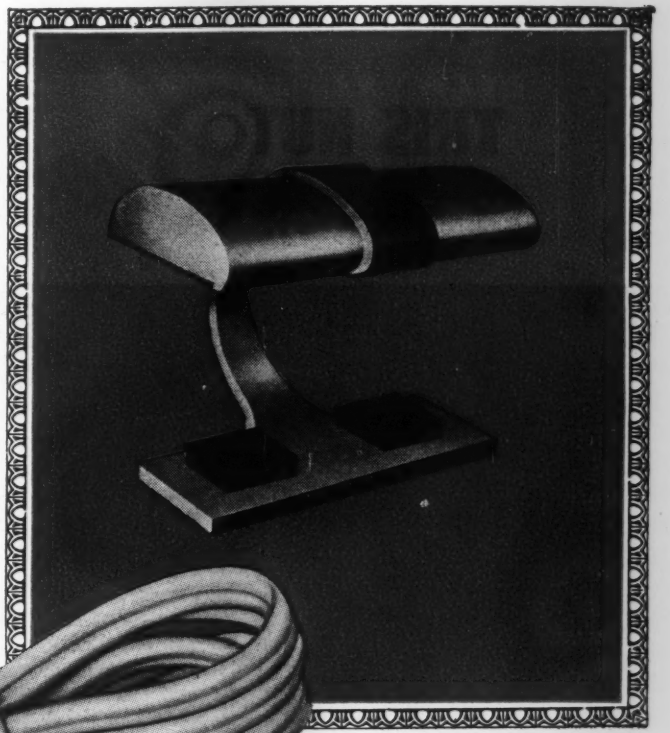
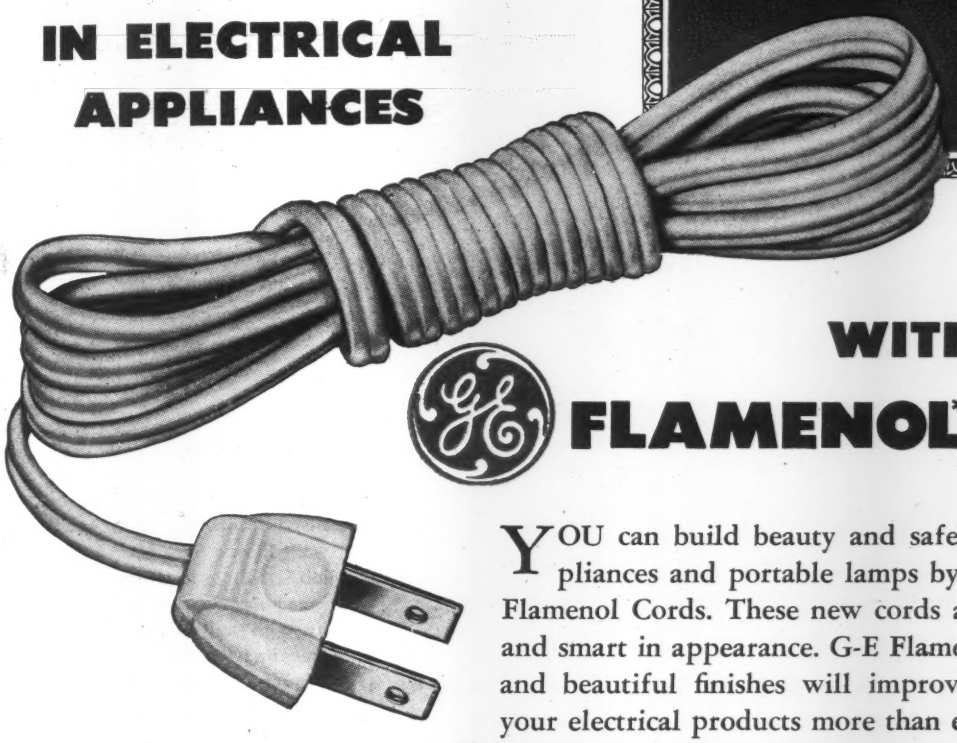
PLUMBING • HEATING • PUMPS

Build Beauty and Safety

IN ELECTRICAL APPLIANCES





WITH FLAMENOL* CORDS

YOU can build beauty and safety in your traffic appliances and portable lamps by equipping with G-E Flamenol Cords. These new cords are modern in design and smart in appearance. G-E Flamenol Cord's rich color and beautiful finishes will improve the appearance of your electrical products more than ever. You'll like their smooth, hard finish that makes them easy and pleasant to handle.

And that's not all. G-E Flamenol Cords offer users of portable lamps, electrical appliances and devices permanent protection. They are built to last with the life of the electrical product. The plug is molded to the portable cord making the power cord set a one-piece construction. This molded-on feature, first designed by General Electric, makes the power cord rugged and provides lasting protection to the soldered connections against strain.

Add greater salability to your electrical products by equipping with the new General Electric Flamenol Cords. For additional information, write to Section Q-1053-41 Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

* Reg. U. S. Pat. Off.

★ ★ ★

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P. M. EWT, NBC. "The World Today" news every weekday 6:45 P. M. EWT, CBS. "The G-E House Party" Monday through Friday 4:00 P. M. EWT, CBS.

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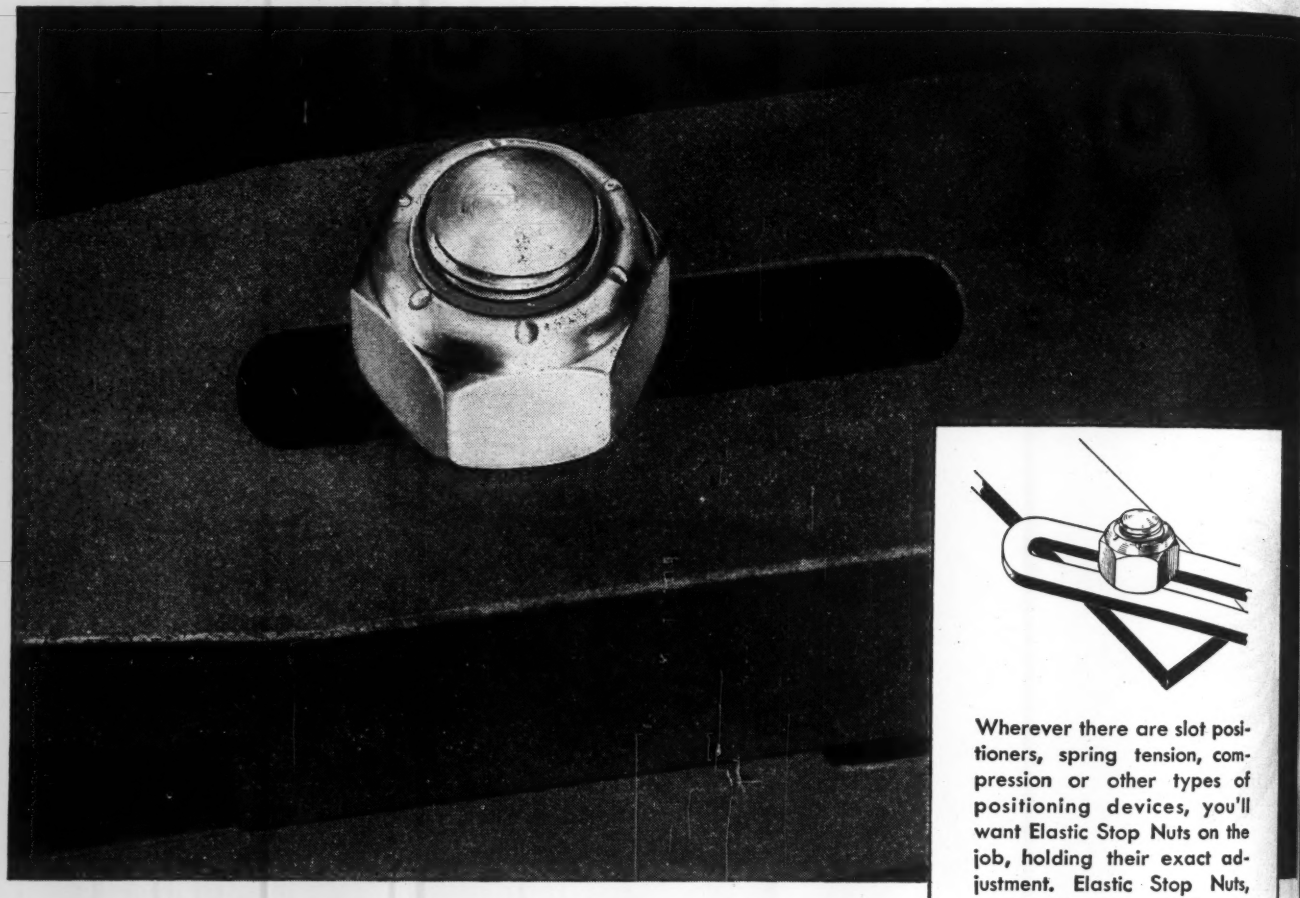
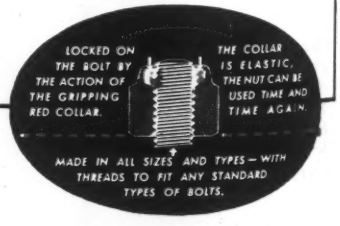
GENERAL ELECTRIC

THIS NUT *knows its place*



Wherever there are slot positioners, spring tension, compression or other types of positioning devices, you'll want Elastic Stop Nuts on the job, holding their exact adjustment. Elastic Stop Nuts, because they successfully resist the effects of vibration, shock, impact and other loosening influences, are ideal for positive maintenance of position.

LOOK FOR THE RED COLLAR
THE SYMBOL OF SECURITY



ESNA
TRADE MARK

It Stays Where It's Put

You'll always find the Elastic Self-Locking Stop Nut where you place it, because this nut always stays put. The Elastic Stop Nut holds an adjustment with a sure grip whether seated against a surface as in the slot positioner illustrated above or unseated on a threaded part.

The Elastic Stop Nut uses its head —because built into it is a red collar. This is an elastic compression collar that molds itself to the individual threads of the bolt, locking tight.

You need no jam nuts, cotter pins or other locking auxiliaries when you use Elastic Self-Locking Stop Nuts. They refuse to loosen, creep or "back off" under the toughest, most critical operating conditions. Yet they never rust or freeze in place and can be easily removed when necessary.

Proved in billions of wartime applications, Elastic Self-Locking Stop Nuts give definite insurance against loose nuts and consequent delays, breakdowns and extra maintenance work. From delicate, precise aircraft installations to heavy-duty tank installations, these nuts with the red elastic collar have shown their gripping power. Elastic Self-Locking Stop Nuts are the sure way to greater safety, economy and reliability.

ELASTIC STOP NUT CORPORATION OF AMERICA

Plants at: Union, New Jersey and Lincoln, Nebraska

Sales Office: 1060 Broad Street, Newark 2, New Jersey

PERFORMANCE CONTROLS THE SKYWAYS

Eastern Airlines Silverliner by Curtiss

YESTERDAY she was ferrying tons of vital war materials over the Hump; flying stout-hearted Paratroopers into battle; hurrying wounded American boys home to peaceful safety. Known to the Army as the C-46, she was more affectionately dubbed the "flying boxcar".

Today, this tried and proved Curtiss Commando is ready for service over the important air lanes of Eastern Airlines . . . luxuriously refitted to carry 36 passengers in deep-cushioned, air-conditioned comfort. New ideas of safety and speed make her one of the world's largest, fastest and smoothest flying twin-engined transports.

These luxury planes have been made possible by the many new aircraft products that were born in the white-hot crucible of war. Many of these products were designed and built by PESCO. And now, in peace, PESCO know-how makes these precision-built hydraulic and liquid pumps and controls available to commercial aviation and other industries. For descriptive literature regarding Pressurized Power and Liquid Flow equipment, write PESCO Products Co., (division Borg-Warner), 11610 Euclid Avenue, Cleveland 6, Ohio.

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . .

BORG-WARNER

PERFORMANCE POINTS TO Pesco FIRST

All are flexible . . . yet each is designed to do a SPECIFIC JOB

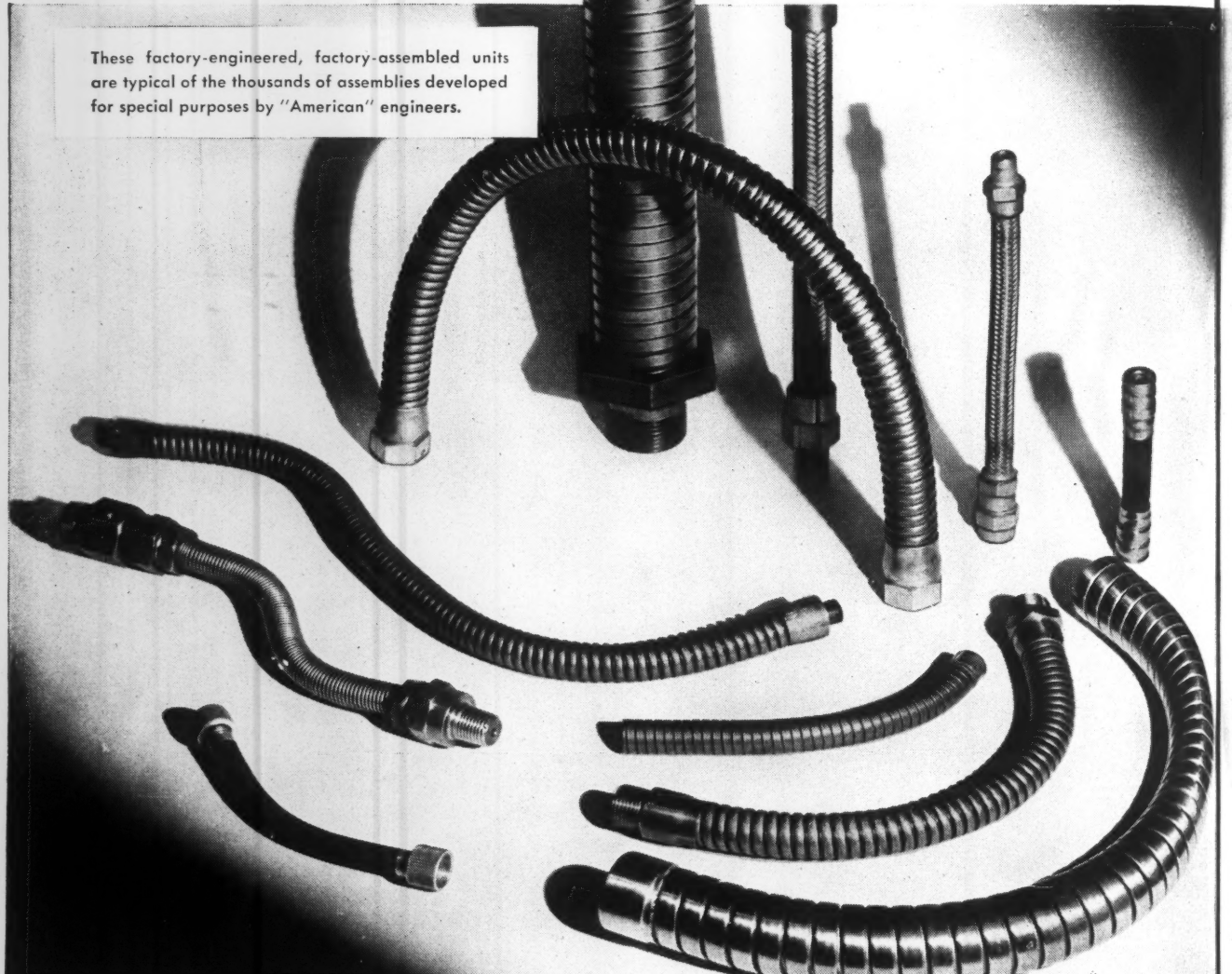
EACH OF THESE flexible metal assemblies has successfully solved a particular problem of vibration, misalignment or movement of parts.

All possess adequate strength and flexibility and are constructed of materials well able to withstand the abrasive and corrosive conditions encountered.

A similarly "tailor-made" assembly can be developed to meet *your* needs. American Flexible Metal Hose or Tubing is made in a wide range of sizes, metals and types of construction. In addition, the broad, practical experience of our Technical Department is at your disposal.

Take advantage of these facilities. For detailed information write for Publication SS-50.

Buy Victory Bonds. Help assure World Peace



These factory-engineered, factory-assembled units are typical of the thousands of assemblies developed for special purposes by "American" engineers.

ANACONDA
from mine to consumer

American Metal Hose

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY • General Offices: Waterbury 88, Conn.

Subsidiary of Anaconda Copper Mining Company • In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

Three billion pounds of Aluminum, expected to be realized as scrap from war production and surplus, should be recognized as *insurance for the future.*

The huge size of this "mine above ground" is industry's guarantee of safety in designing products to take advantage of the unique features of Aluminum Alloys. It is the public's assurance that Aluminum products will be available in profusion.

Properly re-alloyed, and correctly applied, these stock-piles will be the basis of unprecedented expansion in the use of high quality Aluminum Alloys.

Careful selection of the proper alloy and its application for each designing and manufacturing purpose are essential. To help solve these, and other casting problems, expert assistance is available to industry through members of this group without obligation. It will pay you to consult us.

Aluminum Research Institute

111 West Washington Street, Chicago 2, Illinois

MEMBER · ALUMINUM RESEARCH INSTITUTE

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Los Angeles 11, California

The Cleveland Electro Metals Co.
Cleveland 13, Ohio

Federated Metals Division
American Smelting & Refining Company
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Philadelphia 34, Pennsylvania

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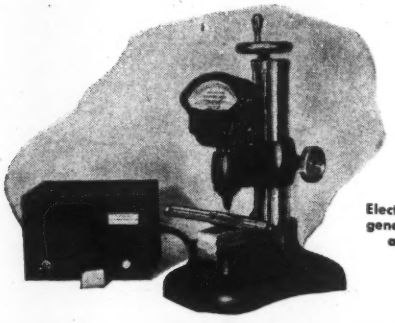
East Chicago, Indiana

Aluminum and Magnesium, Inc.
Sandusky, Ohio

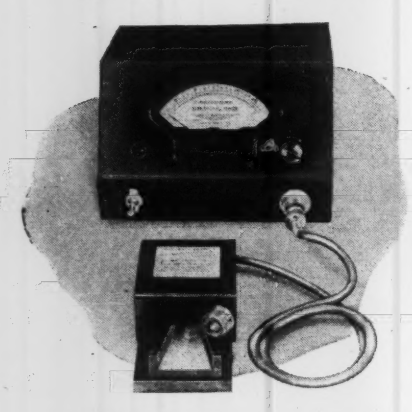
The American Metal Company, Ltd.
New York City 6

Apex Smelting Co.
Chicago 12, Illinois

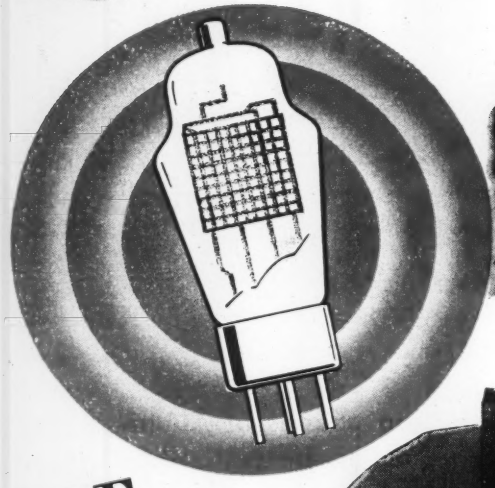
Bearing Race Gauge—measures outer groove to 5/100,000".

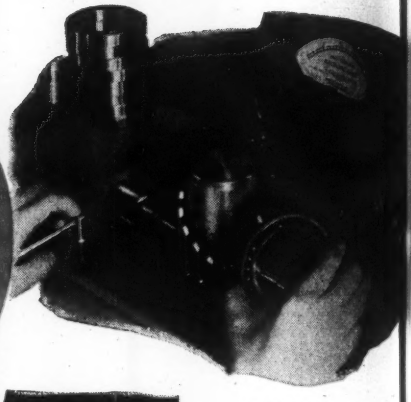


Electronic Comparator—general purpose; checks against Jo-Blocks.

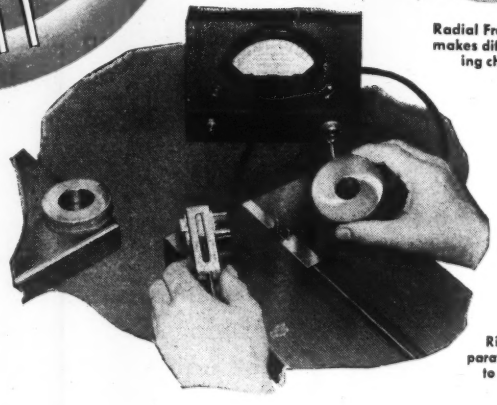


Inner Race Gauge—checks bearing seat to 5/100,000".





Radial Freedom Gauge—makes difficult inter bearing check quickly.



Ring Gauge Comparator—checks gauges to 25/1,000,000".

MIRACLES OF MEASUREMENT

from the magic tube of electronics

TODAY, fine manufacturing calls for working tolerances not of thousandths—but ten thousandths, hundred thousandths and even millionths of an inch! One of the secrets of Jack & Heintz low cost mass production of high precision equipment lies in the ingenious electronic measuring gauges used throughout the eight plants.

With one of these J&H-developed-and-built gauges, even an inexperienced worker can make a complicated precision measurement in a second. For laboratory experiments, Jack & Heintz engineers have made an electronic gauge capable of measuring 2/1,000,000"! One of the shop gauges pictured is calibrated to 25/1,000,000; others in common use are measuring ten thousandths and hundred thousandths day in and day out.

While most of these gauges fall into the "special purpose" classification, they do have one thing in common. That is the basic electronic circuit system that makes them so highly accurate. This method of measurement is new and, as perfected by J&H engineers, has unlimited possibilities for use wherever exceptionally precise checking of parts must be done quickly.

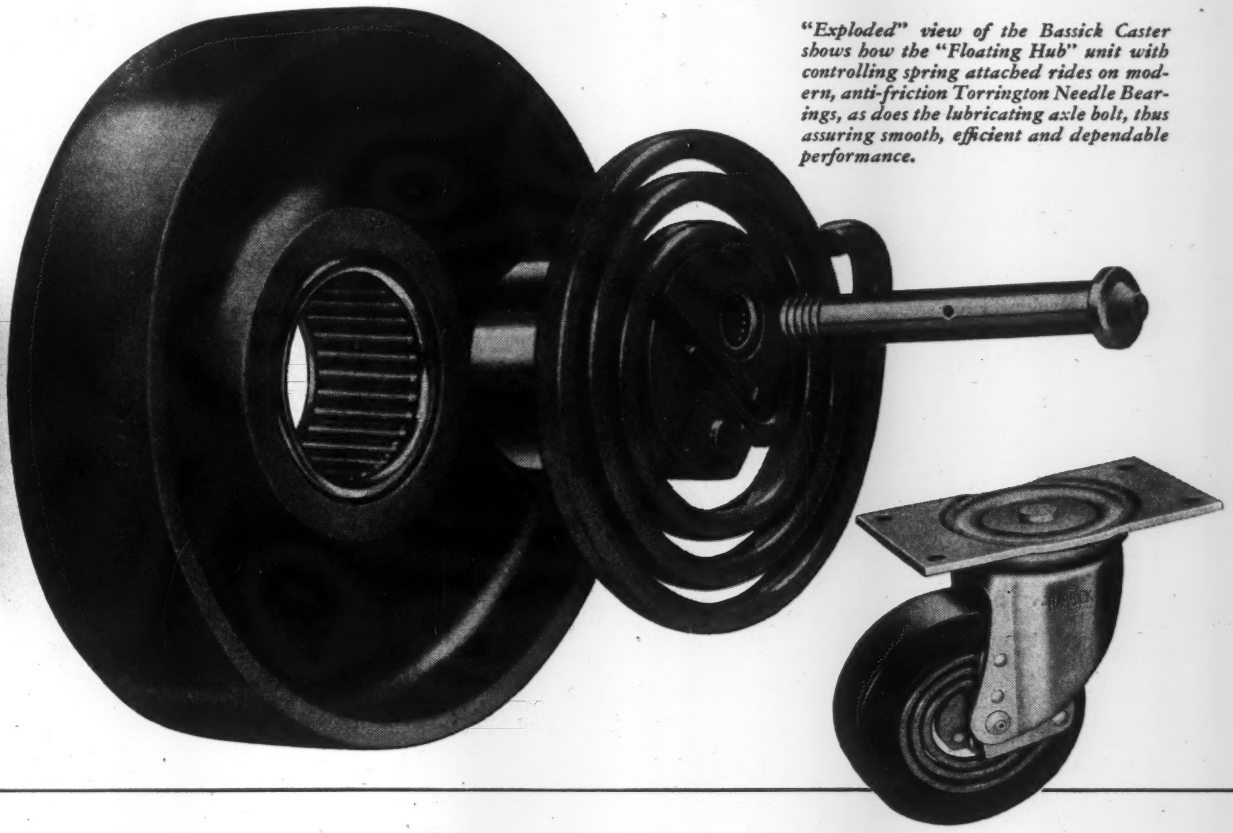
Jack & Heintz has made effective use of these electronic devices to speed war production. They can be adapted to postwar production, too. Merely by changing the holding fixture on each gauge, the magic tube of electronics can be converted to speeding finer things for better, lower cost peacetime products.

If you have a measuring, checking, testing or production problem that calls for forward-seeing engineering such as this, get in touch with Jack & Heintz today!

Jack & Heintz, Inc., Cleveland, Ohio, manufacturers of Aircraft Engine Starters, Generators, Gyro Pilots, Gyro Flight Instruments, Magnetos, Motors.

JACK & HEINTZ
Incorporated

Buy More War Bonds and Stamps



"Exploded" view of the Bassick Caster shows how the "Floating Hub" unit with controlling spring attached rides on modern, anti-friction Torrington Needle Bearings, as does the lubricating axle bolt, thus assuring smooth, efficient and dependable performance.

Needle Bearings Help Make a Rough Ride Smooth

Protection from shock and vibration is of prime importance in equipment such as engine parts trucks, food and dish trucks or portable control panels containing delicate tubes and instruments. When Bassick "Floating Hub" Casters, used on equipment of this type, hit an obstacle they ride over the bump without lifting the load. These ingenious, smooth-running casters are equipped with modern, *anti-friction* Torrington Needle Bearings, which assure easy, efficient performance in the moving of heavy and delicate loads over rough surfaces.

Built for long life, these sturdy, compact bearings can stand up to the countless sudden shocks to which they are subjected in equipment such as the casters described above and provide efficient *anti-friction* operation. Furthermore, the simple, unit construction of Torrington Needle Bearings makes for ease of installation and lubrication.

Perhaps *your* design or production problems could be simplified if you were better acquainted with the many advantages Needle Bearings have to offer, including high load capacity, small size, *anti-friction* operation—and low cost. Our Catalog 32, which contains a world of engineering data, will help you choose the size and type Needle Bearing best suited to meet your particular requirements. We'll be glad to send your copy upon request.

THE TORRINGTON COMPANY

Established 1866

TORRINGTON, CONN. • SOUTH BEND 21, IND.

New York Boston Philadelphia Detroit Cleveland
Seattle Chicago San Francisco Los Angeles Toronto
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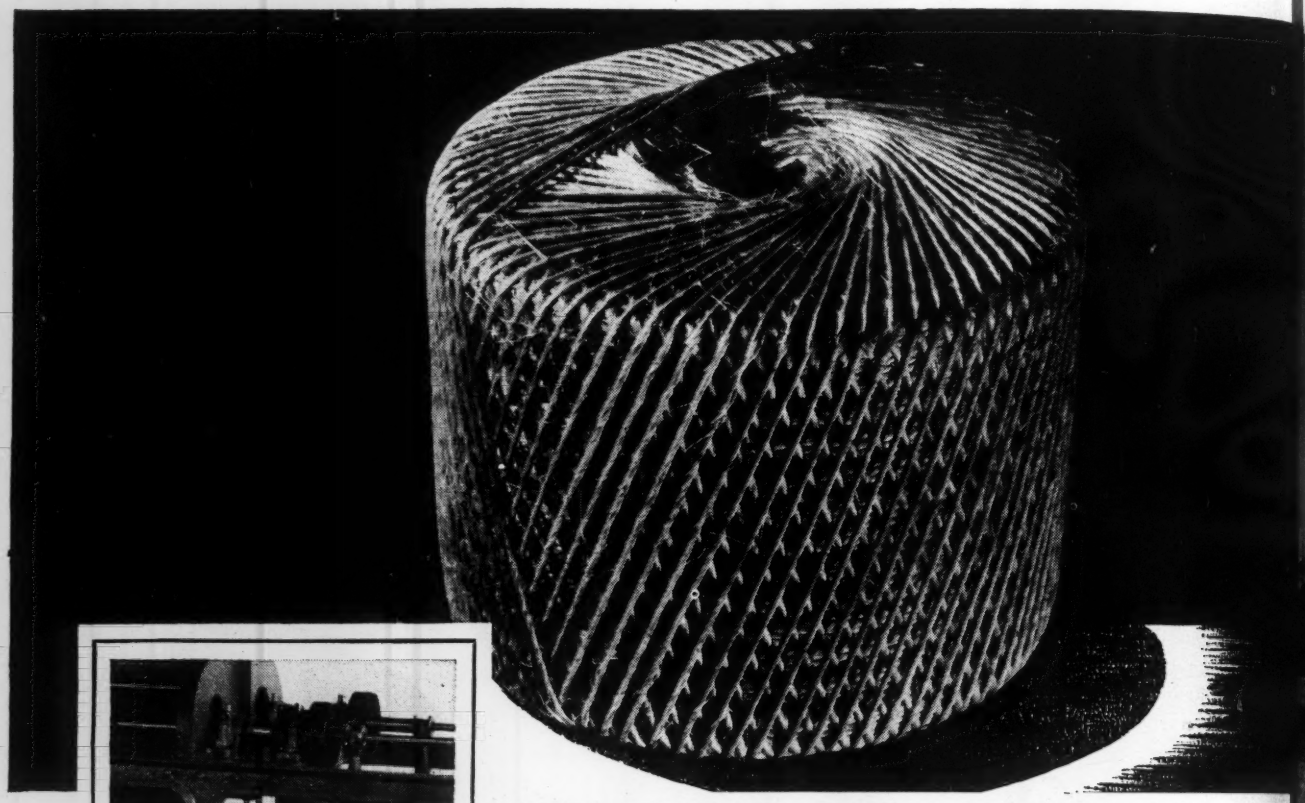
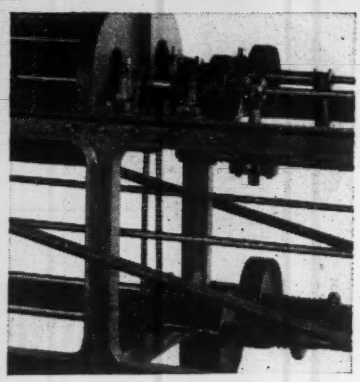
TORRINGTON NEEDLE BEARINGS





These advantages of Diamond Chain flyer drives, capstan drives, and friction drives are important:

1. *Constant velocity ratio.* No variations in relative speeds that lead to non-uniformity of twist and undesired variation of strength and weight of twine.

2. *Non-slipping operation.* Diamond driven spinners produce 2 to 10% more twine, and production is at an unvarying rate.

3. *Less maintenance.* High initial tension is not necessary to avoid slippage. Machine bearing pressures are lower, and bearing maintenance is reduced. Diamond Chains do not stretch—require infrequent attention.

4. *Power saved.* A New England plant found Diamond Chain driven spinners consume 1/5 H.P. less each than belt-driven spinners—enough to pay for the drives in a year.

5. *Long life.* Practically as efficient after years of use as when installed.

DRIVING THE FLYERS THAT TWIST THE "SLIVER"

Is Strictly a Diamond Roller Chain Job

SINCE Diamond Roller Chain Drives were first applied to spinners for hard fiber back in 1915, plants of practically the entire cordage and binder twine industry have turned to these high-efficiency durable drives. One cordage manufacturer that installed one Diamond Drive in 1917 has purchased more than 6000.

So general is their use that it is not unlikely that the next ball of binder twine or the individual yarns in the next piece of rope you see were spun with the help of Diamond Drives.

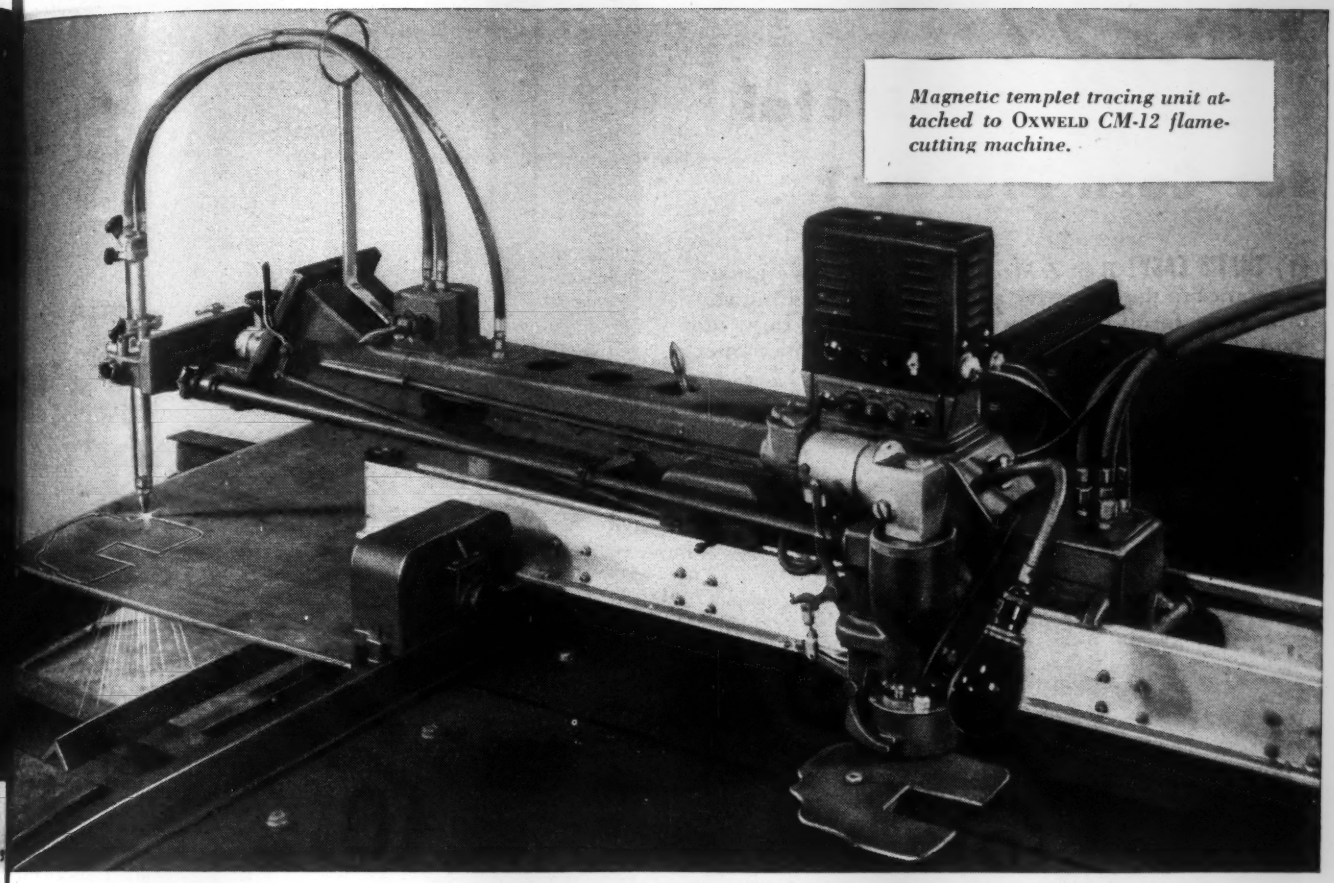
A superintendent remarked as follows: "After putting in 12[illegible] Diamond Roller Chain Spinner Drives in 1920, a second similar installation was made three years later. The first drives ran 16 hours a day for five years and are still running. Diamond Drives eliminate a lot of bad work and pay for themselves in a short time."

Your production may be entirely dissimilar—but chances are that Diamond positive, high-efficiency Drives can help you increase output, insure greater uniformity of product, save power, and reduce maintenance and replacement costs.

Over a half century experience in the application of Diamond Drives is at your service . . . Practical suggestions are yours for the asking. DIAMOND CHAIN & MFG. CO., 435 Kentucky Ave., Indianapolis 7, Ind. Offices and Distributors in All Principal Cities.

DIAMOND ROLLER CHAINS

Write for a copy of Catalog 617—96 pages of roller chain drive data



Magnetic templet tracing unit attached to OXWELD *CM-12 flame-cutting machine.*

MINIMIZE MACHINING ON SHAPE-CUT PARTS

Use Magnetic Tracers on OXWELD Flame-Cutting Machines

OXWELD magnetic tracers automatically guide the oxy-acetylene blowpipe to produce identical shapes time after time. These tracers follow templets of any shape—even with 90-degree corners—without deviation. Templets can be finish-machined to exact dimensions, and because they are made of steel, they retain their accuracy on quantity runs. OXWELD magnetic tracers are simple in their operation... a magnetic roller, following the prepared templet, drives the machine at a uniform controlled speed.

If you use an OXWELD CM-12, CM-15, or CM-23 flame-cutting machine, you can obtain a magnetic tracing unit for it. If you are considering a new machine for repetitive cutting of complicated parts with close tolerances, or if you are now shaping metal parts by another method, you should investigate the advantages of an OXWELD machine equipped for magnetic tracing. Complete information on making templets is supplied with each unit.

Write to any Linde office for additional information.

BUY AND HOLD UNITED STATES VICTORY BONDS AND STAMPS

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

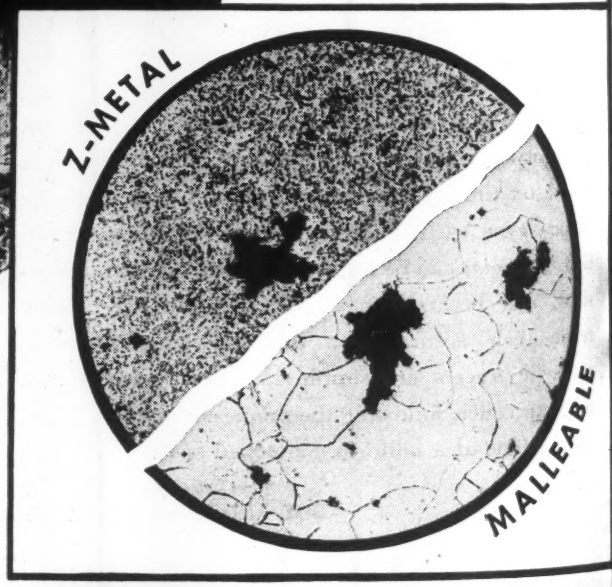
LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD, UNIONMELT APPARATUS
OXWELD AND UNIONMELT SUPPLIES

The words "Linde," "Oxweld," "Prest-O-Lite," "Prest-O-Weld," "Purox," "Union," and "Unionmelt" are trade-marks of Union Carbide and Carbon Corporation or its Units.

Why *Pick* Z-Metal for Corn Pickers?

① THAT'S EASY! Rex Z-Metal chain belts have greater resistance to the corrosive and abrasive operating conditions of farm machinery service. Neither rain, nor mud, nor dust, nor heat will easily destroy their operating efficiency.

② ON THIS CORN PICKER, for example, Rex Z-Metal chains are used for many driving and conveying functions. The ability of Z-Metal chain belts to retain their pitch under severe shock loads and strains makes them ideal for the intricate operations involved. Their high strength, uniformity, toughness, resistance to corrosion and abrasion make them the "pick" for corn pickers, other agricultural implements, food processing and many other types of machines.



③ WHAT MAKES Z-METAL SO TOUGH? Here's the secret! Z-Metal has a matrix of ductile iron with spheroidal particles of iron carbide uniformly distributed throughout, as shown in this photo-micrograph (200 times magnification). This spheroidized structure insures the uniform high strength of Rex Z-Metal chain belts.

* * *

Rex Z-Metal chain belts are the answer to many drive and conveyor problems involving heavy loads or corrosive conditions. The Rex Man will be glad to help you with your chain belt application problems. For complete information on Rex Z-Metal chain belts write for your copy of Bulletin No. 437. Address Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wisconsin.

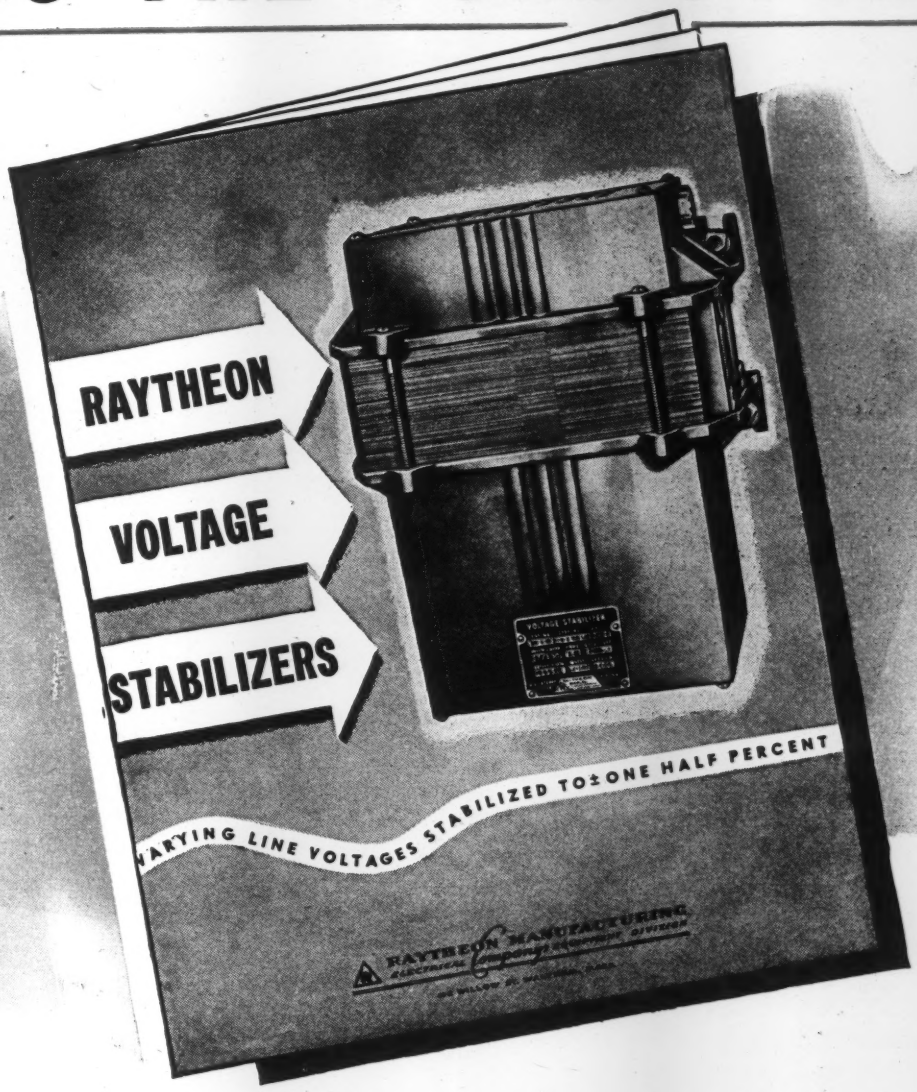
REX CHAIN BELTS

Manufactured in every available type for the positive transmission of power, timing of operations and conveying of materials

CHAIN BELT COMPANY OF MILWAUKEE

Rex Chain Belt and Transmission Division, Rex Conveyor and Process Equipment Division, Milwaukee 4, Wisconsin • Baldwin-Duckworth Division, Springfield 2, Massachusetts

HERE'S THE FULL STORY



SEND FOR IT TODAY . . .

IN A DETAILED, 8-page bulletin now available, Raytheon Manufacturing Company tells the complete story about the dependable Raytheon Voltage Stabilizers. These trouble-free magnetic-type units . . . with no moving parts to get out of order . . . stabilize AC from ordinary voltage sources to within plus or minus a half percent, throughout their full rating.

The bulletin includes such useful information as electronic applications, performance features, principles of operation, operating characteristics, graphs, specifications of the three immediately available designs, cased, uncased, and endbell, and a price list.

We urge you to send for your copy promptly. Ask for Bulletin DL48-537, and address your request to Raytheon Manufacturing Company, Electrical Equipment Division, Waltham 54, Mass.

RAYTHEON
MANUFACTURING COMPANY
WALTHAM 54, MASS.

ELECTRICAL EQUIPMENT DIVISION

Excellence in Electronics

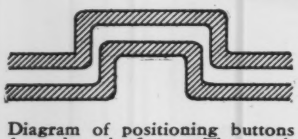


Diagram of positioning buttons formed on the flanges. The punch side was made larger than the die side so that the metal would not pierce.

Redesign for Stamping Cuts Housing Weight in Half

Castings formerly used for these counting device housings weighed 3 lbs. 4 oz. each. The stamped redesign is only about half of this weight. The whole job could not be stamped, so a screw machine part was attached to one half through a "D" hole. To permit assembly of an oil cup, this same half had a hole pierced in it and was then extruded to permit assembly of an oil cup. This method saved making the parts o a heavy gauge material throughou The design was also worked out so tha one set of tools made both halve This is another example of a stampin user saving money through Preste ingenuity. We invite you to talk ove your problems of design or productio with our engineers or representative

WORCESTER PRESSED STEEL CO.

811 Barber Avenue — Worcester 6, Mass.

ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883

Representatives in Alexandria Virginia, Buffalo, Canton Ohio, Chicago, Denver, Detroit, Fort Worth, Indianapolis, Los Angeles, New York, Philadelphia, Syracuse, Tow

In contrast with the conventional L-shaped bracket, this U-bend construction minimizes the stress on the metal chassis and prevents distortion when mounting bolts are tightened. The mounting foot is sufficiently flexible to compensate for normal tolerances in height of case, and for variations in dimensions of the bracket itself.

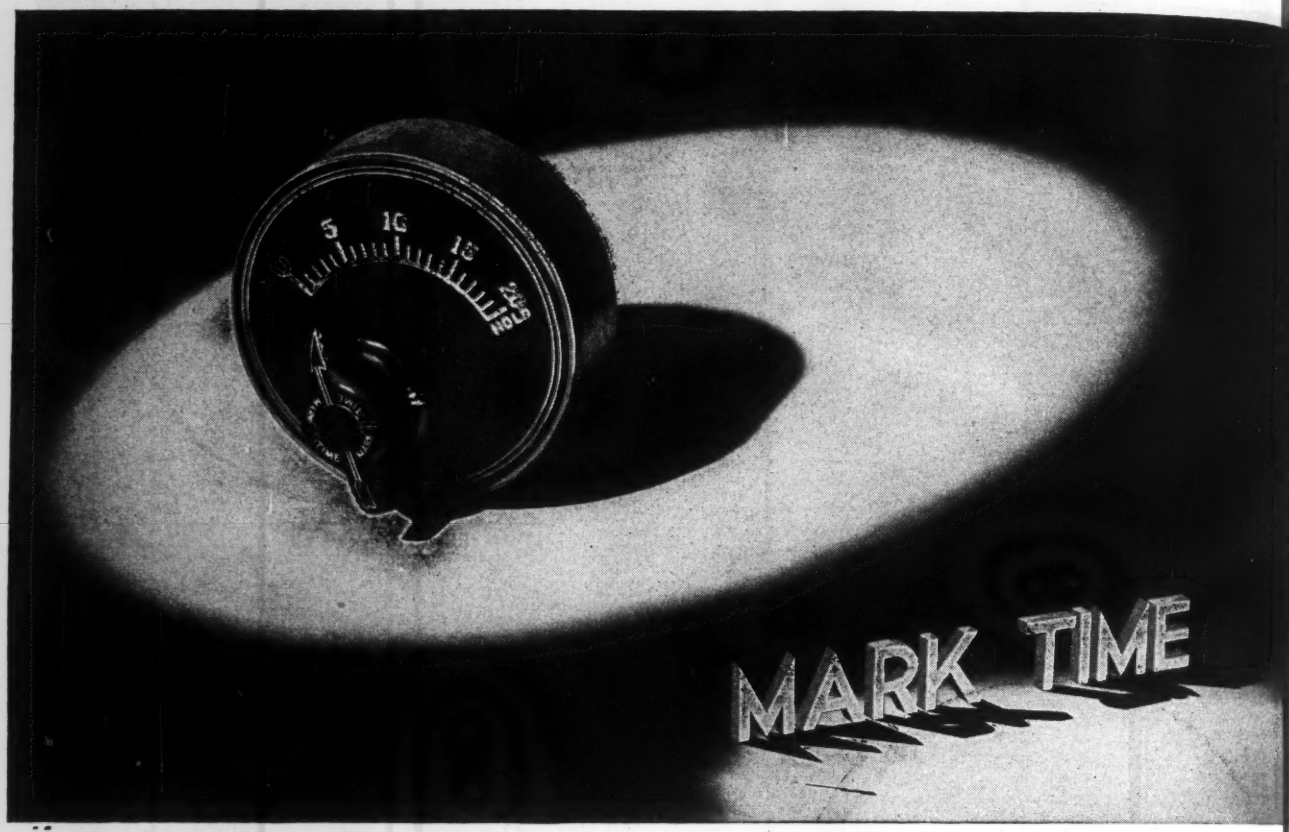
The brackets are sufficiently thick to provide strong, rigid support. A corrosion-resistant finish of lacquered zinc plate assures a good ground from capacitor to chassis. The brackets have either one or two mounting holes depending upon the width of the capacitor.

These brackets are an exclusive feature on G-E capacitors. Spade-type and L-shaped brackets can still be obtained when desired. Ask for Bulletin GEA-4357 for information on the G-E capacitors that can now be furnished with this improved feature. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

CAPACITORS

Buy all the BONDS you can —and keep all you buy

GENERAL ELECTRIC



NEW *Electrical Time Switch*

DEVELOPED PARTICULARLY FOR ONE MANUFACTURER'S NEW EQUIPMENT

Has Time Control been utilized to its best advantage on YOUR new products?

Our Engineering Department will be pleased to talk with you about your applications. Simply write and arrange an appointment.

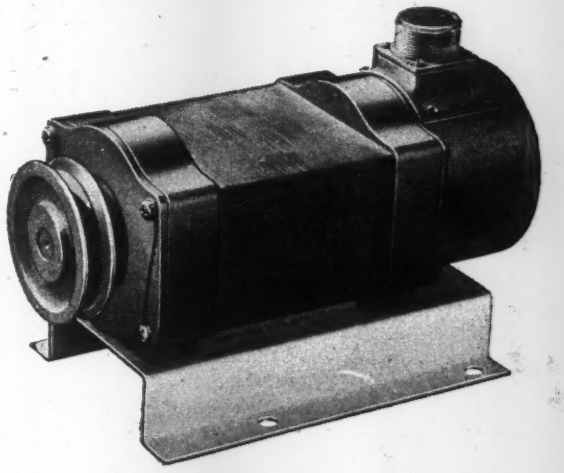
MARK-TIME
REG. U.S. PAT. OFF.
Timing Devices

M. H. RHODES, INC.
MANUFACTURERS HARTFORD 6, CONN.

500 WATTS
TO 1200 WATTS CONTINUOUS DUTY

20 LBS.
TO 25 POUNDS MAXIMUM

a lot of power ...with little weight



Developed originally as an airborne generator for remotely located radar stations, this especially designed and built EEMCO unit sets new standards for a light weight source of electric power. Only through advanced research and manufacturing methods could so much output be made available for *continuous duty* with so little weight. Weighing but one-half as much as formerly available equipment, many commercial, rural and marine applications can now be filled.

Generator Data: Totally enclosed; glass insulated, available in 500, 600 and 1200-watt capacities; 32 and 120-volt; ratings at 50° temp. rise; ball-bearings lifetime lubricated; also available with integral panel containing meters and voltage regulator. Immediate production contracts can now be accepted.

EEMCO engineers are prepared and experienced in solving *tough* generator and motor problems; in the building of drives, gearing unit or control devices. Submit your problems to EEMCO today.

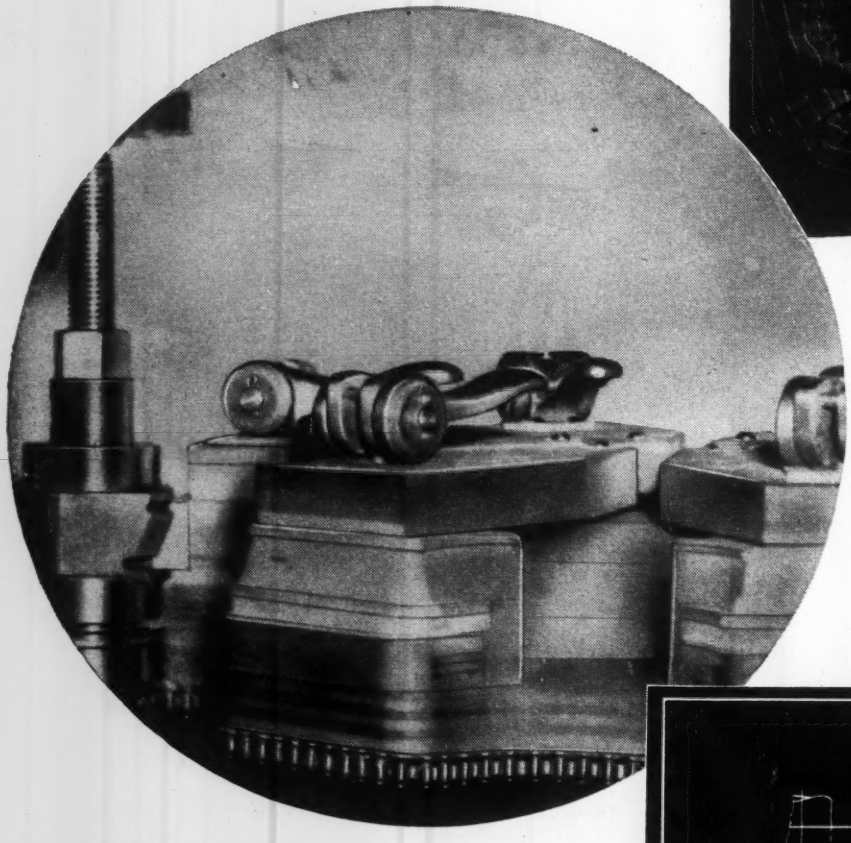
Send for your copy of EEMCO's new catalog . . . "Custom Built Motors for a World of Needs" is now available. Ask for your copy — no obligation.

ELECTRICAL ENGINEERING AND MFG. CORP.
4606 West Jefferson Boulevard, Los Angeles 16, California

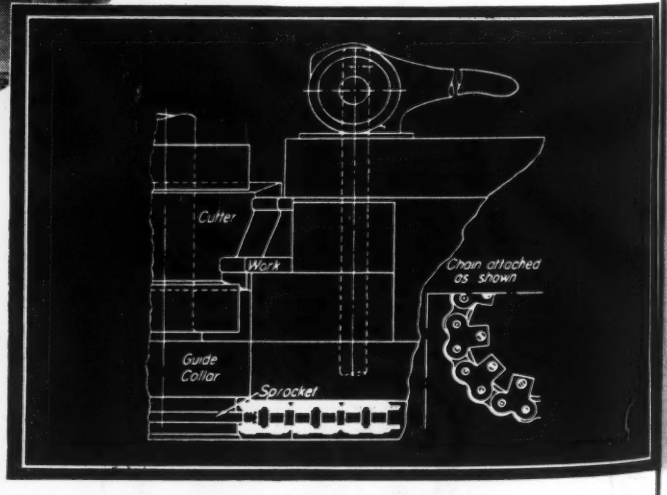
EEMCO

USING THE *Usual* TO SOLVE THE *Unusual!*

① UNUSUAL APPLICATIONS of usual methods of transmitting power, timing operations, or moving materials have often been the solution to many a tough engineering puzzle. Baldwin-Rex roller chain belts, a standard solution, have solved unusual as well as usual problems.



② IN THIS WOOD SHAPER they are used to revolve the irregular form containing the work to be shaped. An unusual application—but here again the inherent possibilities of Baldwin-Rex roller chain belts provided an ideal answer to a perplexing problem.



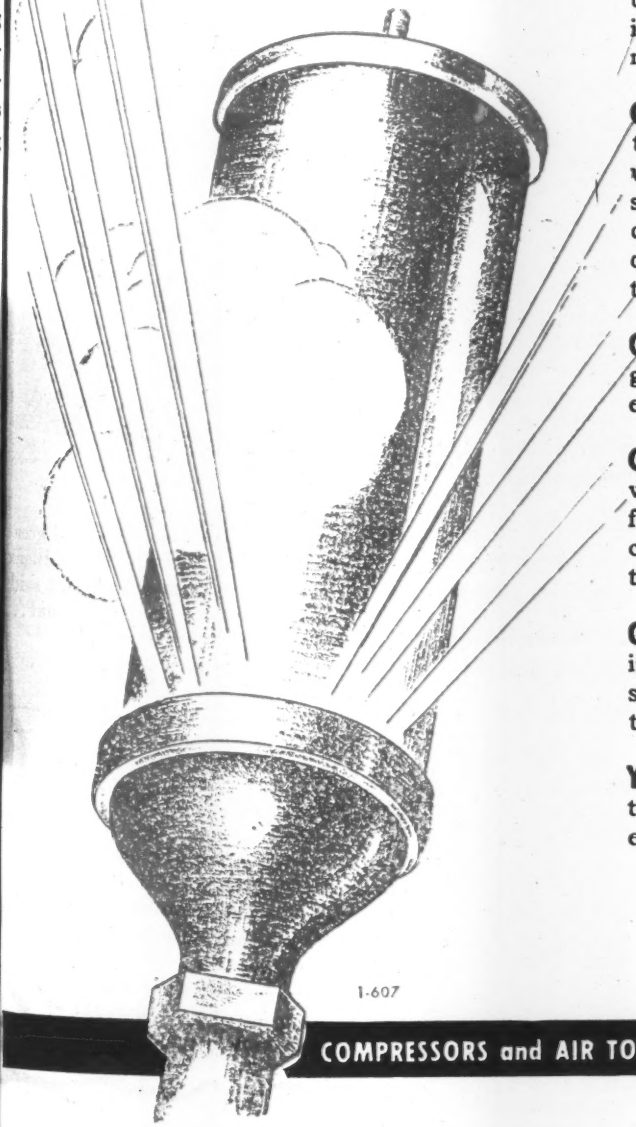
③ THE CHAIN IS APPLIED as shown in this diagram. It is fitted around the base of the form and fastened by screws extending through standard M-35 attachment links. Work is revolved by the feed sprocket engaging the chain rollers. Air pressure holds the form in contact with the guide collar. The next time you are faced with an unusual problem, investigate the usual problem-solving abilities of Baldwin-Rex roller chain belts.

For catalogs on Baldwin-Rex roller chain belts or competent information on your specific drive problems, write **BALDWIN-DUCKWORTH** *Division of* **CHAIN BELT COMPANY,** *320 Plainfield Street, Springfield 2, Mass.*

BALDWIN-REX *ROLLER CHAIN BELTS*

Baldwin-Duckworth Division, Springfield 2, Massachusetts • Rex Chain Belt and Transmission Division, Rex Conveyor and Process Equipment Division, Milwaukee 4, Wisc

LIKE MAN, COMPRESSED AIR works to be FREE



Compressed Air has an inherent urge to be free . . . to escape from the confinement of a storage tank, or pipe, or the cylinder of a machine.

To attain freedom, *Compressed Air* will expand and push until all of its energy has been expended or released. This is *compressed air power* at work. Engineers apply it to make man's work easier, better, and more productive.

Compressed Air pushes pistons or the blades of wheels to exert its power in air tools, such as drills, riveters, wrenches, hoists and rock drills. It operates air brakes, the switches and signals in railroad yards, and the controls of complicated processes . . . clamps the jaws of chucks in machine tools. It "fires" torpedoes from their tubes, operates their controls, and spins their gyroscopes.

Compressed Air supplies oxygen for combustion in oil, gas, and coal furnaces and boilers on land and sea. It is essential in blast furnaces and foundry cupolas.

Compressed Air creates powerful streams or blasts of air when it is suddenly released. These create waves of sound for whistles . . . hurl particles of sand for smoothing metal castings . . . spray paint . . . carry huge quantities of grain through tubes . . . scavenge and cool the barrels of naval guns.

Compressed Air expands as it tries to obtain freedom, inflating tires, displacing water ballast when a submarine surfaces, and raising sunken ships. It bubbles through liquids to pump by "air lift," and to agitate them.

Yes, like man, Compressed Air works in countless ways to be free. Perhaps it can do more for you. Our applications engineers will be glad to help in any way possible.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS and AIR TOOLS built and applied by the men who know AIR POWER

The office manager, the artist, and the photographer!

(AND WHY THEY VISITED THE DRAFTING ROOM)

First time any of them had visited the drafting room!

But they'd heard that an Ozalid machine—recently installed to reproduce engineering drawings—could also reproduce—and simplify—much of their own work.

The Chief Draftsman obligingly listened to their accounts of varied problems and said:

"Ozalid can save you man-hours and dollars . . . as it does us."

He demonstrated how anything drawn, typed, printed, or photographed on translucent material could be reproduced in seconds—not minutes. AND be reproduced—not as a negative—but as any one of ten types of positive, Ozalid prints.

In different colors—black, blue, red, or sepia; on different base materials—paper, cloth, foil, or film.

He showed how these Ozalid prints could be used in many unique ways—for jobs beyond the scope of any other reproduction process.

THE ARTIST was intrigued by the manner in which advertising displays and folders could be made, and at the speed with which a layout could be altered and a new effect created.

Now, he said, he could do twice the work. (*He wondered if he could collect twice the pay.*)

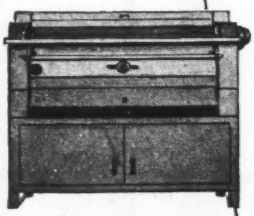
THE PHOTOGRAPHER was speechless when he saw Ozalid Dryphotos (continuous-tone photographic prints) produced in 18 seconds flat from a positive-film "master." Not one bath was necessary—just the same two steps employed to make all Ozalid prints—Exposure and Dry-Development.

THE OFFICE MANAGER, a man of great reserve, examined an Ozalid Rapid Black print of a typewritten report and said, "I'd swear this is the typed original . . . except that I can't smudge it."

OZALID

DIVISION OF GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, NEW YORK

Ozalid in Canada—Hughes-Owens Co., Ltd., Montreal



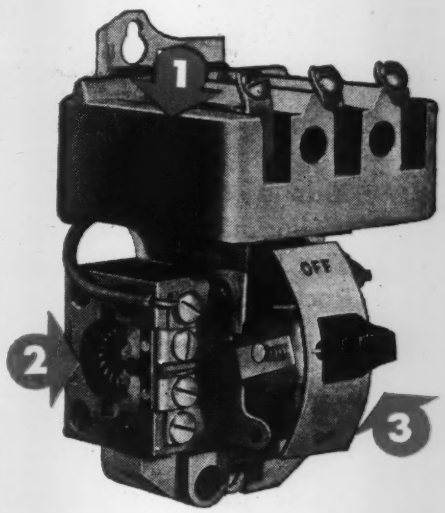
Suggestion:

If you have an Ozalid machine in your drafting room, stop by and ask for a demonstration. If you haven't adopted Ozalid as yet, write for *Simplified Printmaking.* It tells the whole story and contains samples of the 10 types of Ozalid prints you can make.

Pick this enclosure... ..for this manual motor starting job

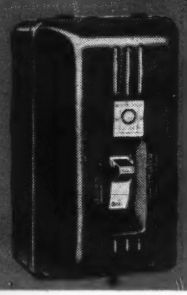
....get these Westinghouse Starter features!

1. **"De-ion" Arc Quenchers.** Arcs go out *quick*, making contacts last longer.
2. **Bi-Metal Overload Relay.** Accurate calibration for life of starter. Permits harmless overloads—protects motor against dangerous running overloads or stalled rotor conditions.
3. **Quick-Make, Quick-Break Action.** Prevents teasing, prolongs contact life.



NEMA Type 1

STANDARD SHEET STEEL ENCLOSURE



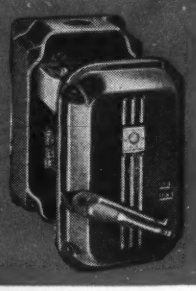
General-Purpose Indoor Applications —normal atmospheric conditions

"DE-ION" MOTOR WATCHMAN 10-100-S

NEMA Types III, IV & V

WATERTIGHT AND DUST-TIGHT CAST-IRON ENCLOSURES

(Rubber gasket between case and cover)



Outdoor applications including:

- Docks
- Canal locks
- Subways
- Tunnels

Indoor applications including:

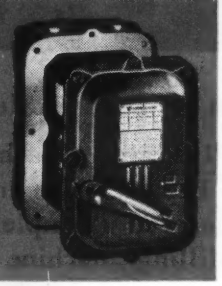
- Dairies
- Breweries
- Steel mills
- Cement mills
- Woodworking plants

"DE-ION" MOTOR WATCHMAN 10-100-W

NEMA Types VII & IX

CAST-IRON ENCLOSURE FOR HAZARDOUS LOCATIONS

Class I, Group D and Class II, Groups E, F & G (Ground flanges on case and cover)

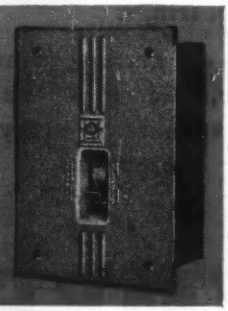


- Refineries
- Distilleries
- Varnish plants
- Flour mills
- Grain elevators
- Sugar, cocoa, coal pulverizing plants
- Aluminum and magnesium processing plants

"DE-ION" MOTOR WATCHMAN 10-100-U

NEMA Type 1—S

FLUSH-MOUNTED SHEET STEEL ENCLOSURE



Same applications as standard sheet steel enclosures—where flush mounting is desired.

"DE-ION" MOTOR WATCHMAN 10-100-P

See your Westinghouse Distributor for full details or write for D. B. 10-100. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

J-60614

Westinghouse PLANTS IN 25 CITIES... OFFICES EVERYWHERE **MOTOR CONTROL**

This special 2-spindle, 2-way horizontal boring machine was designed and built by The Ingersoll Milling Machine Company, Rockford, Illinois.

It is used for boring, counterboring and facing bearing recesses, end bores and counterbores in Timken Tapered Roller Bearing axle housings for railroad rolling stock.

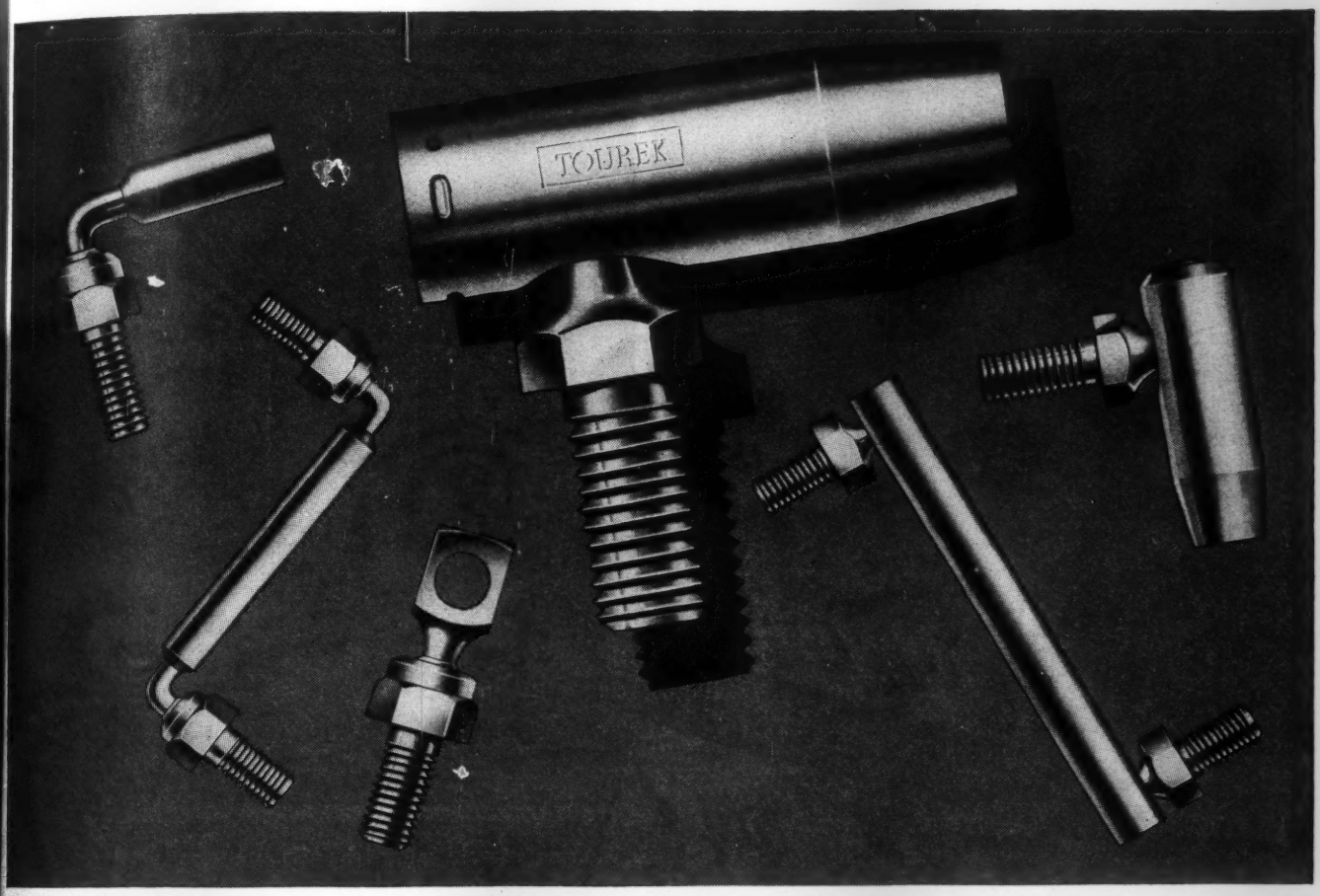
These precision operations necessitate precision equipment, which this Ingersoll boring mill, equipped with Timken Bearings on both spindles, provides.

The Ingersoll Milling Machine Company uses Timken Bearings in many of its other machines, too. For example an Ingersoll Type "B" Milling Machine which has 4 heads—2 horizontal and 2 vertical—uses 18 Timken Bearings.

To be sure of getting Timken Bearing performance, see that the trade-mark "TIMKEN" appears on every bearing that goes in your equipment.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN
TAPERED ROLLER BEARINGS



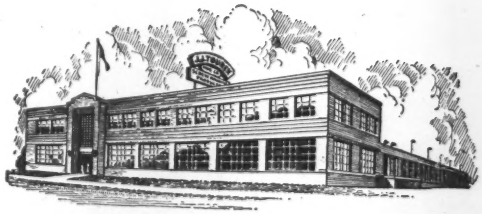
TOUREK BALL JOINTS . . . .

The Recognized Standard for Design and Performance!

THE major industries throughout the country specify Tourek Ball Joints where this type of product is needed . . . their plus performance contributes to the safety, dependability and service-life of the products in which they are used.

Tourek has the ability and facilities to meet fully your exact requirements for ball joints . . . *in any quantity . . . stock types available for immediate shipment . . . or custom-made to your blueprints on reasonable delivery schedules.*

WRITE FOR COMPLETE DATA.



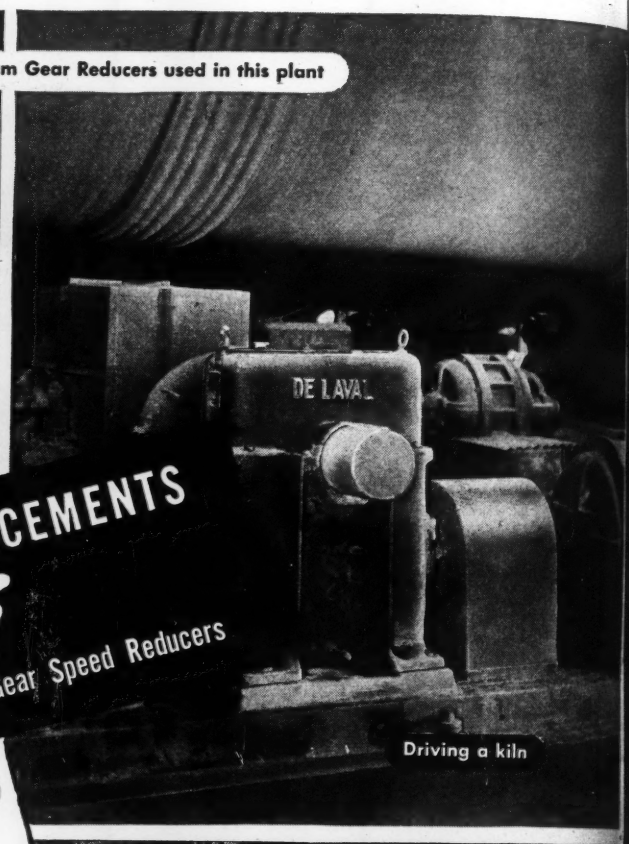
MAKERS OF PRECISION SCREW MACHINE PRODUCTS

J. J. TOURER MFG. CO.
4701 W. 16th St. Chicago 50, Ill.

TOUREK
FAMOUS BALL JOINTS

A few of the many De Laval Worm Gear Reducers used in this plant

Driving a kiln feeder



Driving a kiln

PRACTICALLY NO PARTS REPLACEMENTS in 19 YEARS

Reported by Plant Employing Many De Laval Worm Gear Speed Reducers

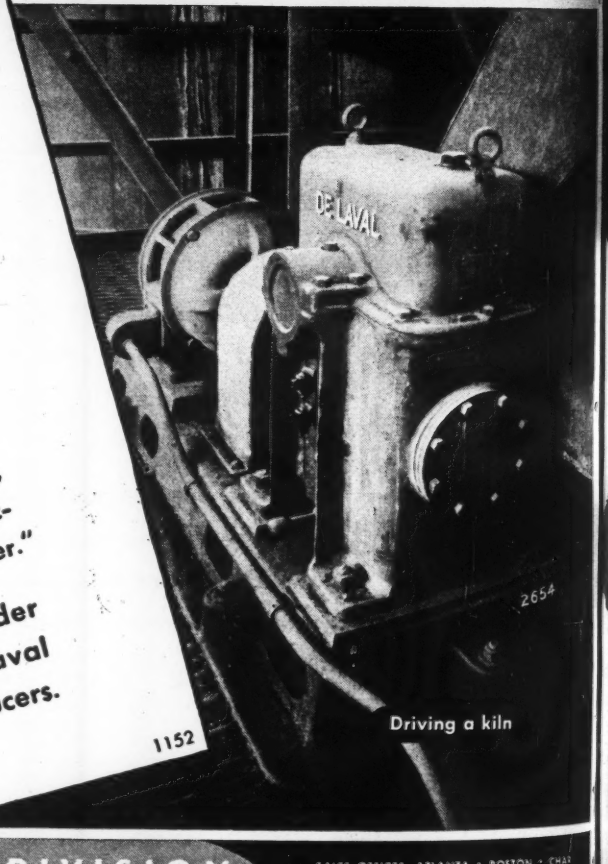
How's that for Reliability?

De Laval Worm Gear Speed Reducers have given such good service in a certain cement mill (name furnished on request) that the Plant Superintendent has written of their performance:

"There are about 175 reducers of various sizes in operation in this plant on a wide diversity of jobs; and during the last eighteen or nineteen years, since the original ones were installed, we have had to make practically no replacements of worms, wheels or bearings. In fact, there has never been any interruption in production by reason of the failure of a speed reducer."

For reliable, trouble-free service under severe conditions, specify De Laval Worm Gear Speed Reducers.

1152



Driving a kiln

TURBINES • HELICAL GEARS and WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

WORM GEAR DIVISION

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • HELENA • HONOLULU • HOUSTON KANSAS CITY • LOS ANGELES • MANILA MONTREAL • NEW HAVEN • NEW ORLEANS NEW YORK • PHILADELPHIA • PITTSBURGH ROCHESTER • ST PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TORONTO • TULSA VANCOUVER • WASHINGTON, D.C. • WINNIPEG And Cities in Central and South America

Why don't you get together on proof that you both can count on?

Confidential note to machine-builders and manufacturers of mechanical products (with a couple of side remarks to users):—

It's as simple as this: Build into your machine or product, as an integral part, a Veeder-Root Counting Device that registers strokes, turns, pieces, trips, and many other units of performance . . . mechanically or electrically. Then your customers can *see* when your guarantee period is reached . . . for the Facts-in-Figures are right there in front of them in plain, bold black and white. So there's no room for argument, no needless loss of goodwill or future business through lack of positive proof.

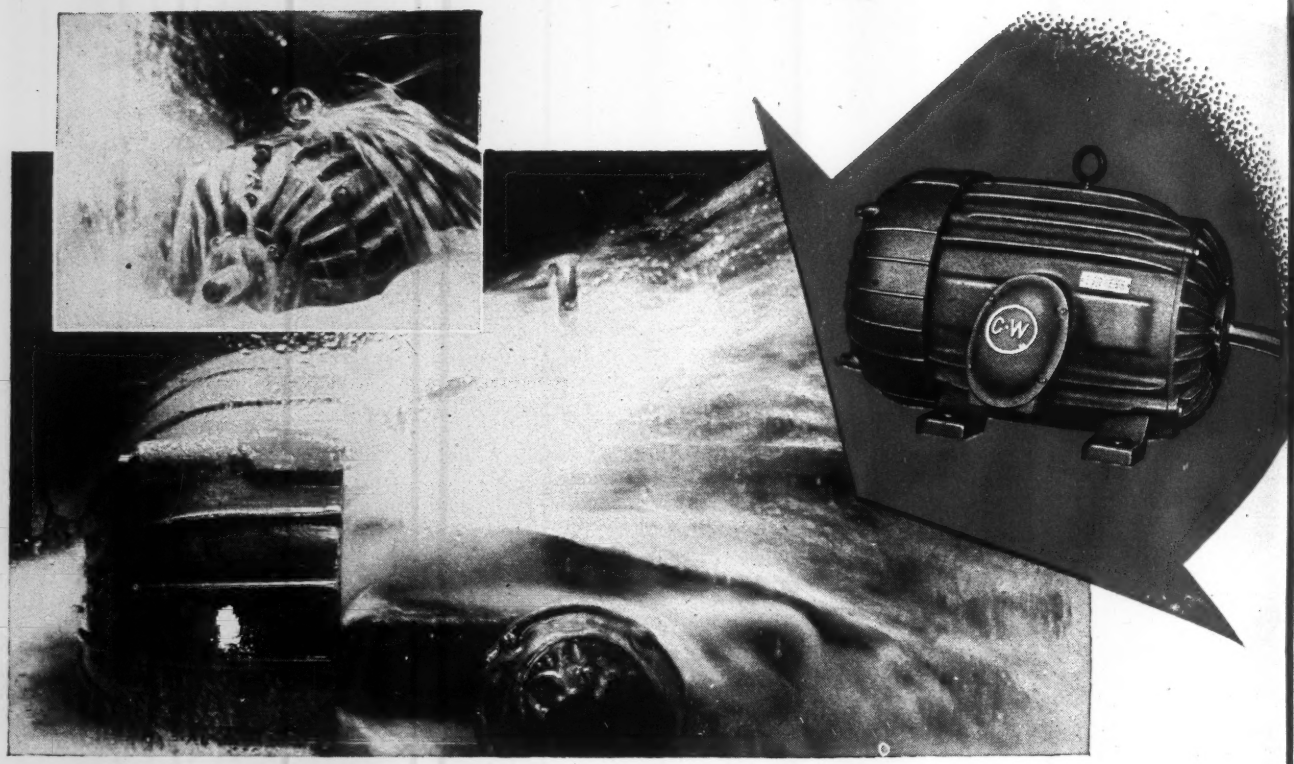
There are Veeder-Root Devices that will record the exact number of performance-units constituting the guarantee period. And then these devices will go on proving to your customers that they're getting all the performance you built into your product. You are invited to take "*Count*sel" with Veeder-Root engineers, who will show you just how you can protect and profit yourself with built-in Veeder-Root *Count*rol.

The Counting House of Industry

VEEDER-ROOT INC.

Hartford 2, Connecticut

In Canada: Veeder-Root of Canada, Ltd., Montreal
In England: Veeder-Root Ltd. (New address on request)



A MOTOR takes a bath to prove a point

You can easily see that this new a-c **SEALEDPOWER** is a unique motor—with many exclusive features—but how will it stand up under really tough operating conditions? Can it withstand excessive moisture? What will be the effect of large quantities of dust in the surrounding atmosphere?

Answers had to be found to these questions before the motor could be offered to industry as an *improvement* over existing fan-cooled designs. So two brutal tests were devised:

In performing the first test a standard **SEALEDPOWER** motor was placed in a tank containing six inches of water, and run for eight hours without stopping; it was then shut down and the operation repeated the following day. All during the operating period the ventilating fan of the motor continued to throw water over the frame, shields, bearing housings, shaft and junction box (see illustrations), thoroughly drenching the entire exterior of the motor and yet, at the end of the test, the motor was taken apart—and the inside was found to be "bone" dry! Excessive moisture will offer no problem to this motor.

In the second test, a dense atmosphere of French chalk was kept whirling around the motor by means of fans. But, at the conclusion of this test, not a trace of chalk was found on the windings or elsewhere within the motor—conclusive proof that the **SEALEDPOWER** motor is truly dust tight.

An exclusive Crocker-Wheeler design, the **SEALEDPOWER** motor is suitable for applications where you have been using conventional fan-cooled motors. Why not try one of these motors—in an unusually damp or dusty location?

Send for full information. Please write on your company letterhead—no obligation.

THIS COUPLING IS UNIQUE, TOO

The Crocker-Wheeler resilient flexible coupling consists of a spider, a flange, a ball retaining cover and six synthetic rubber balls—that's all there is to it! And yet, this is more than just a trouble-free coupling—it actually adds years to the life of both the driving and driven machines.

The balls transmit torque, absorb shock and vibration, yet do not transmit end thrust. Available for shaft diameters up to 8", these couplings require no lubrication, no maintenance of any kind. Write for complete information.

CW-

CROCKER-WHEELER
AMPERE, N. J.
TRADE MARK REG. U.S. PAT. OFF.
DIVISION OF JOSHUA HENDY IRON WORKS

CROCKER-WHEELER ELECTRIC

A DIVISION OF JOSHUA HENDY IRON WORKS, AMPERE 22 NEW JERSEY

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • WASHING

SQUIRREL CAGE MOTORS WOUND ROTOR MOTORS DIRECT CURRENT MOTORS GENERATORS FLEXIBLE COUPLIN

HYCAR's versatility means money saved in every industry

Here's a good example

TO increase the production of an oil well it is frequently necessary to pump hydrochloric acid into it, and then wash the well. That means the pumps have to handle not only the acid, but the washing compound plus a mixture of mud, salt water, oil, gas, and slush.

Because of this unusually severe service it used to be common practice to replace valve inserts after every job. But now HYCAR valve inserts are widely used, and as many as *8 acidizing jobs have been performed with a single set of HYCAR inserts without any signs of leakage or failure.*

HYCAR's chemical and physical properties—listed in the box at the right (and available in specifically selected combinations)—make this performance possible. These same properties in other applications in *every* industry have made possible superior performance of resilient rubber parts, longer life, and reduced maintenance expense.

Ask your supplier for parts made from Hycar. Test them in your own applications — difficult or routine. You'll find for yourself that parts made from Hycar will save you money, give you more efficient service — that it's wise to use Hycar for long-time, dependable performance. *Hycar Chemical Company, Akron 8, Ohio.*

CHECK THESE SUPERIOR FEATURES OF HYCAR

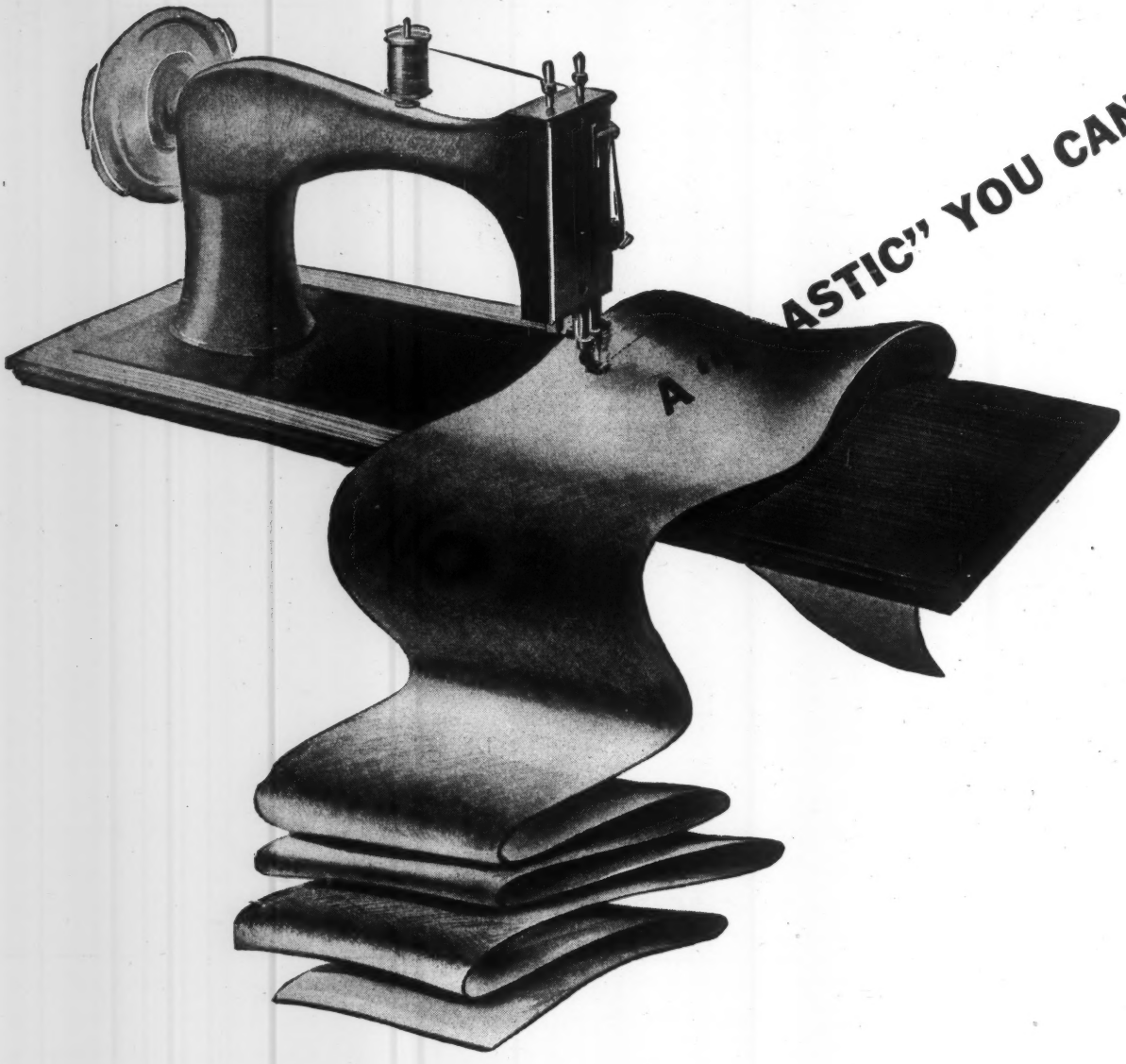
1. *EXTREME OIL RESISTANCE — insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW — even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY — down to —65° F.*
6. *LIGHT WEIGHT — 15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

Hycar

Reg. U. S. Pat. Off.

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubbers



Of course, it isn't technically a plastic, but it is so near to it that we use the term to emphasize its use possibilities. Through various chemical treatments we build into or upon a cloth structure the characteristics of a plastic joined with the flexibility, strength and fabricating possibilities of cloth. Any kind of cloth from a fine cambric to burlap.

Think of these materials as "flexible plastics" in helping to solve your post war material problems. Do not confuse these and other Holliston processes with ordinary cloth finishing. We prepare cloth with special characteristics to serve special needs — functional or decorative.

Consult our Research Department.

The HOLLISTON MILLS, Inc.

Processors of Cloth for Special Purposes

NORWOOD, MASSACHUSETTS

Sales Agents in Principal Cities

Cloth Bound

A cloth bound book is bound to be kept — bind your

CATALOG — SALES MANUAL — INSTRUCTION BOOK, ETC.

in HOLLISTON Book Cloth — durable, impressive, hard-to-soil, easy-to-clean.

Write for samples.

Consult your printer.

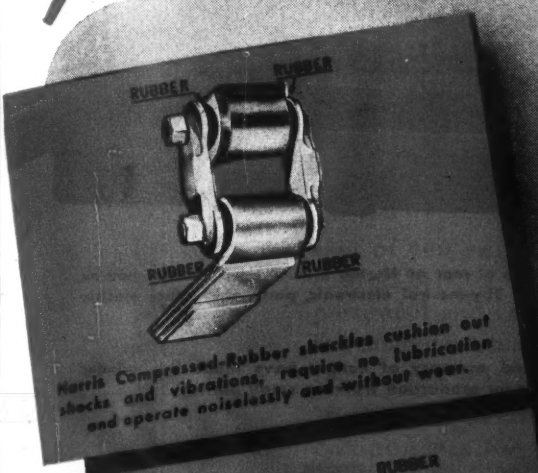
SPECIAL FINISH

HOLLISTON special finish cloths meet special needs —

TRACING CLOTH — PHOTO CLOTH — RUBBER (PROCESSING) CLOTH — BOOK CLOTH — SHADE CLOTH — SIGN CLOTH — TAG CLOTH.

Cloth combined with special compounds, filled, impregnated, coated — to form a material with characteristics of a plastic and the flexible strength of a woven fabric.

VIBRATION & NOISE CONTROL BY Harris PRODUCTS . . .



Harris Compressed-Rubber shackles cushion out shocks and vibrations, require no lubrication and operate noiselessly and without wear.

Duflex mounts come in a variety of sizes, shapes and load ratings for vibration - isolation of radio, aircraft and electrical apparatus.

Torflex Flexible shaft-couplings compensate for parallel or angular misalignment, provide electrical insulation and smooth out impulses.

Torflex Flexible Bearings consist of a stretched tube of rubber between two metal sleeves which hold the rubber in the stretched state. Pressure exerted by the rubber on the metal sleeves insures a high-capacity mechanical bond. They come in a wide range of sizes.

Harris products, engineered for the control of vibration and noise were not "war born" - on the contrary they were created, designed and widely used in civilian fields years before the war.

We pioneered in engineered vibration and noise control and much of the progress made in this highly specialized field is due to our engineers, who have designed and created many items for a wide variety of applications.

Millions upon millions of Harris products are serving industry and have been for years.

When war was declared our government took advantage of our many years experience with the result that Harris products were used extensively on Bombers, Fighters, Jeeps, Trucks, Tanks etc.

Engineers are becoming aware of the fact that the control of vibration and noise will greatly increase the utility, efficiency and life of their products, consequently many new as well as old products on the peacetime market will be equipped with Harris products.

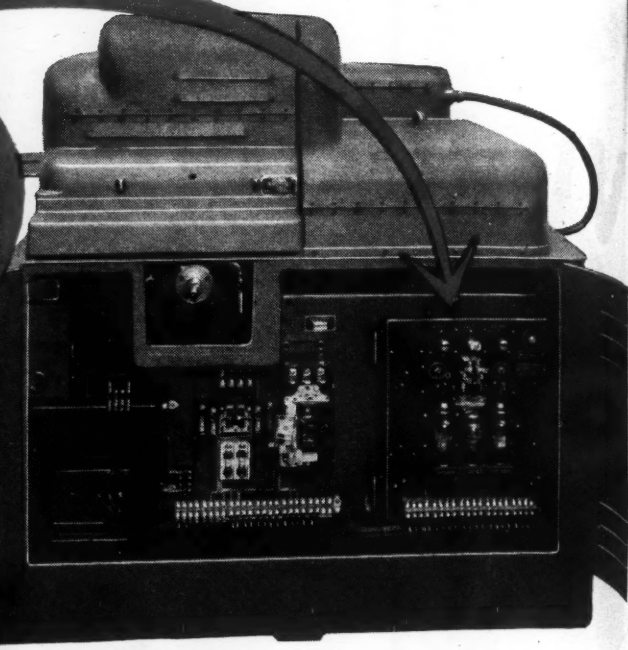
Our experience as specialists in vibration and noise control are available to you in the solution of your problems. Drop us a line today and acquaint us with the facts of your problem.

HARRIS PRODUCTS CO.

CLEVELAND 4, OHIO, U. S. A.

Branches: 44 Whitehall St., New York • General Motors Bldg., Detroit, Mich.

ELECTRONIC DRIVE FROM A-C SOURCE



(Above)
Enclosure at rear of Norton 4-in. Type C grinder houses compact Thy-mo-trol electronic panel and other electric control.

(Left)
Ease and accuracy of control have made this grinder popular for production work on small parts.

PUTS 10 TO 1 SPEED RANGE AT HER FINGERTIPS

AN advanced type of precision grinder, built by the Norton Company, Worcester, Mass., has won wide favor for its high production rates on small machine parts. Its outstanding characteristic is simple, yet highly flexible, control, right at the operator's fingertips.

Work speeds on this grinder are set on a dial—any level from 100 to 1000 rpm, with constant torque throughout—thanks to the use of a G-E *Thy-mo-trol drive.* Jogging control is also easily adjustable over a wide range, and dynamic braking gives fast stops. Yet the machine operates on a regular a-c power supply.

FOR WIDE-RANGE STEPLESS SPEEDS

A Thy-mo-trol drive is a complete, co-ordinated set of equipment including an electronic panel, transformer, control station, and a d-c motor matched to the job. It's the increasingly popular choice of machine builders *and users* for applications requiring stepless speed control, adjustable accelerating torque, or constant speed under changing loads.

Standard Thy-mo-trol drives can be obtained in ratings from 1/8 to 25 hp. In special cases, speed ranges as high as 100 to 1 have been furnished. The experience of G-E engineers is available to help make Thy-mo-trol an integral part of your product or processing set-up. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

676-190-8930

Buy all the BONDS you can—*and keep all you buy*

THY-MO-TROL DRIVE

An Unusual Service for PRECISION *Sub-contracting*

ATLAS . . . with its highly technical staff of 400 engineers, machine and product designers and toolmakers, is now in position to offer the services of its personnel and complete machine and assembly sections to a few manufacturers who require precision sub-contracting of radar units, instruments or other types of difficult assemblies.

We have undertaken and successfully produced many "secret" components for war plants and with that experience have something to offer you that goes far beyond the abilities of the normally "good" plant.

Here is what we can do for you:

I Provide complete engineering service for new projects . . . finish your partially completed work.

II Design and build all tooling for production (either in your plant or ours).

III Produce, assemble and test intricate, precise units or products on sub-contract.

IV Design and build high speed automatic special machines for any type of production.

On request we will send you the Atlas brochure which explains in detail all of our services and pictures the modern engineering, machine and assembly sections of our plant. If you desire quick action, telephone or telegraph for a consultation with one of our key men. It is quite probable that we can lift "a load off your shoulders onto ours".

An Award for ARMY E NAVY *Precise Production*

ATLAS TOOL & DESIGNING CO.
ATLAS METAL STAMPING CO.
Castor & Kensington Aves., Phila. 24, Pa.

"Customer Engineering Service"

ASSURES CORRECT APPLICATION OF

Redmond MICROMOTORS

For continuous duty operation, Type "T" Micrometors are built in sizes up to 1/25th horsepower, and Type "L" up to 1/40th horsepower. Direct Current series and shunt wound types are in sizes up to approximately 1/20th horsepower. Below are shown Micromotor applications typical of those on which Redmond "Customer Engineering Service" offers valuable assistance for assuring best results.

AC APPLICATIONS

DC APPLICATIONS

SPECIALISTS in small motor engineering are ready to serve you. Backed by years of experience and complete equipment, these Redmond engineers have the ability to thoroughly analyse and solve difficult applications. They'll tell you exactly how to use Micromotors for obtaining fine performance, trouble-free operation and long life. Get acquainted with Redmond *"Customer Engineering Service"*. Write us today.

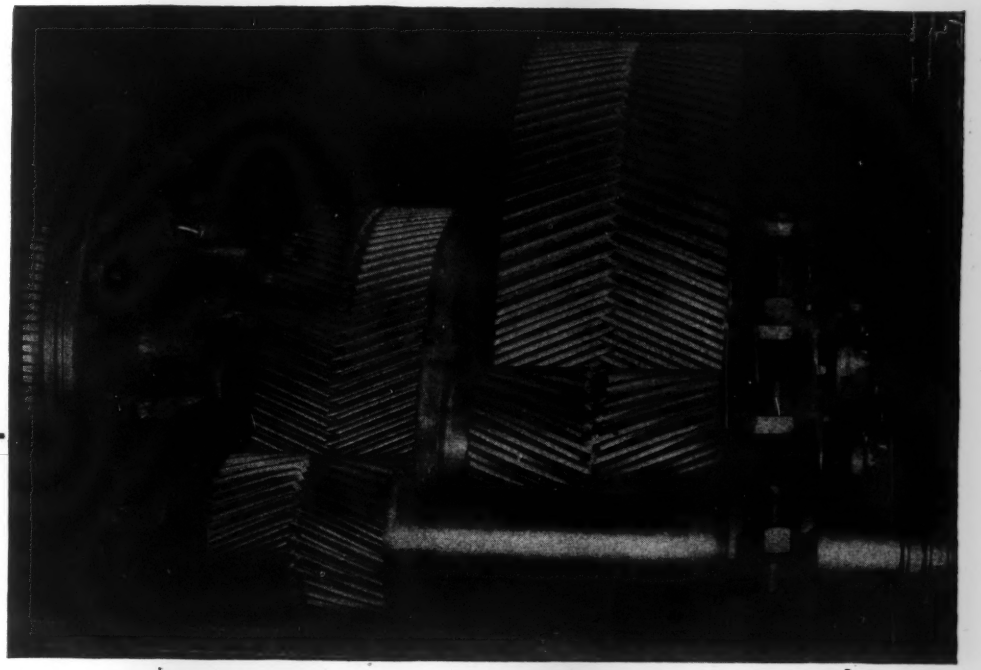
Redmond COMPANY, INC.

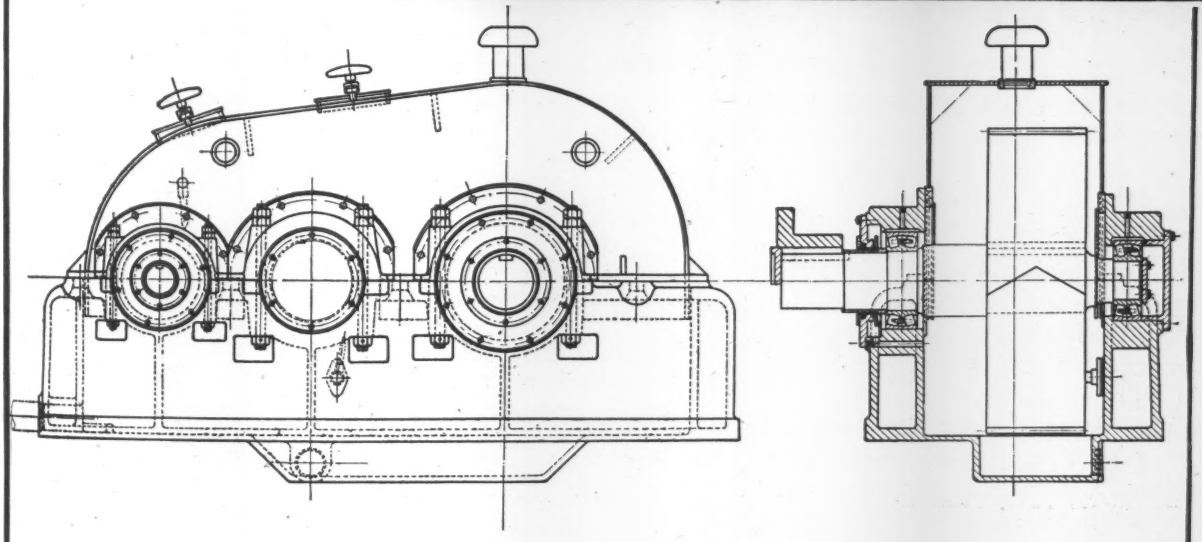
OWOSSO, MICHIGAN, U. S. A.

Composite view of Redmond facilities in which more than 2000 people are engaged exclusively in manufacturing Micrometors, Dynamotors, Speed Controllers and Blowers.

THE RIGHT BEARINGS

For Gear Drives!

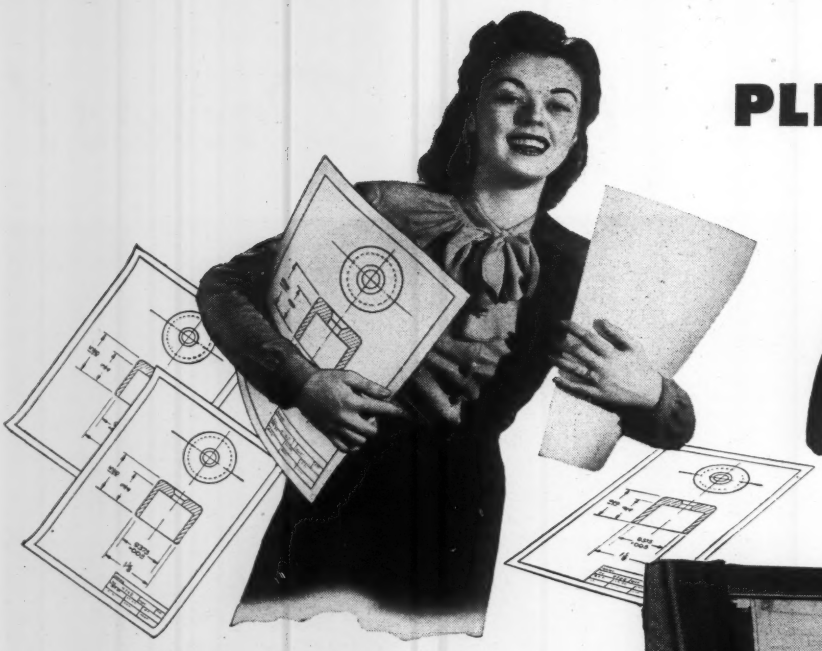




iving mills 24 hours a day, 365 days a year, is a job at calls for dependability, self-alignment, high load-arrying capacity and long life in bearings. That's why SKF Spherical Roller Bearings are used on this Gear rive. They're on the job the clock around. Their lf-aligning properties eliminate overloads caused by saalignment. Their full capacity is always available for useful work. And they roll smoothly for years with inner races tight on the shafts and outer races sliding in the gear case. Only occasional lubrication is required, and fussy adjustments are never needed. All of which can be summed up in one word: PLUS-PERFORM-ANCE. SKF Industries, Inc., Front Street and Erie Avenue, Philadelphia 34, Pa. 5874

SKF

ROLLER BEARINGS



PLENTY OF PRINTS

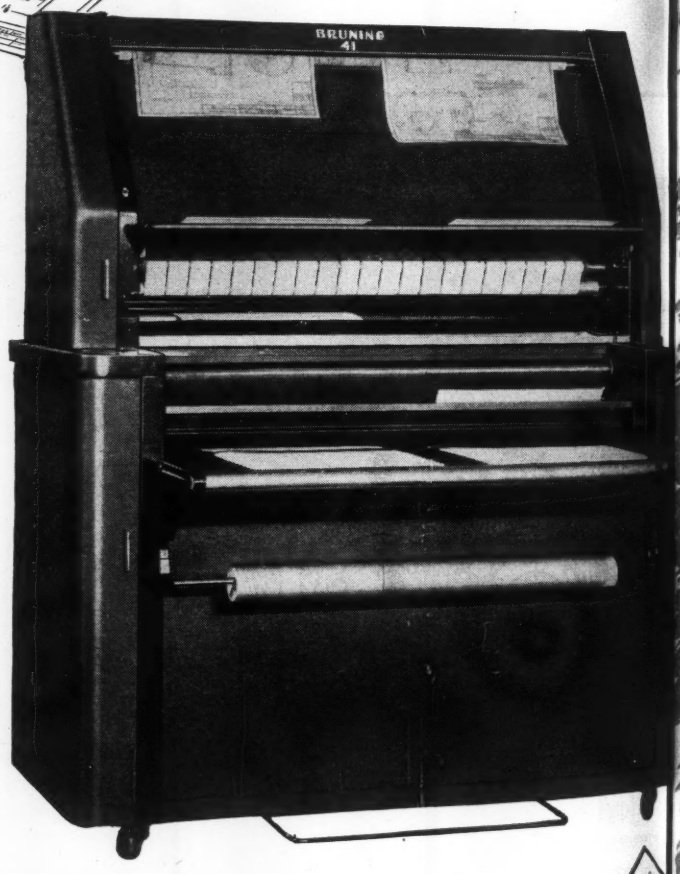
ALWAYS-

FOR THE VITAL

60%

● For the 60% of all print users who require prints in medium quantities, here's good news! The new Bruning Model 41 Printer-Developer provides prints in ample supply for your needs—exposes and develops Black and White Prints from roll stock or cut sheets—yet is priced much lower than a large-capacity, high-volume machine!

With its brilliant, new 2,000 watt glass mercury arc light, the Model 41 gives you clear, sharp prints—has an actual printing and developing width of 46 inches. Control has been amazingly simplified—no experienced operators needed. And because the Model 41 requires no plumbing, you can put it anywhere in drafting room, engineering department or office—have prints *where* you want them. Get full information about the Bruning Model 41 Printer-Developer—send today for free illustrated literature.



The Bruning Model 41 Printer-Developer embodies a radically new method of cooling to provide greater uniformity of prints and greater operator comfort.

It's Positively Right—In Bruning Black and White

CHARLES BRUNING COMPANY, INC.
4726-48 Montrose Avenue, Chicago 41, Illinois

Please send me complete information on your Model 41 Printer-Developer—and on other Bruning printing and developing machines for making Bruning Black and White Prints.

Name.....

Company.....

Street.....

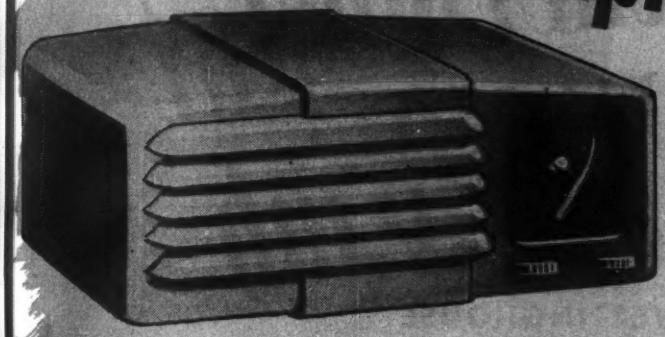
City..... State.....

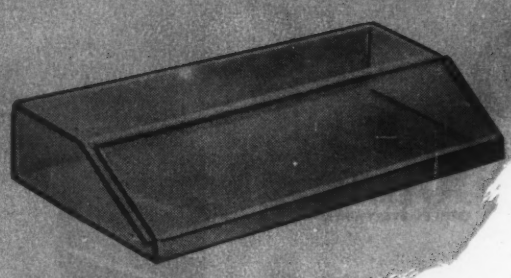
CHARLES BRUNING COMPANY, IN

Since 1897

NEW YORK	CHICAGO		LOS ANGEL
Atlanta	Boston	Detroit	Houston
Kansas City	Milwaukee	Newark	Pittsburgh
St. Louis	San Francisco	Seattle	

Planning an improved product?





Take advantage of Celanese* custom-built Plastics

Do you know **... that Celanese produces a flame-resistant thermoplastic (LUMARITH XF) with the high speed molding qualities of standard cellulose acetate? ... that dial faces, covers, transparent shields and bezels can be molded to optical clarity from LUMARITH XX? ... that LUMARITH EC offers sub-zero toughness, warpage resistance, lightness and excellent moldability, all in one composition?**

THESE are but a few of the new developments in Celanese cellulosic thermoplastics that soon will be available for civilian use. The war service of Celanese plastics include some of the toughest jobs thermoplastics have ever tackled: *aircraft control wheels molded over metal, corrosion resistant film insulation, interchangeable flashlight parts for arctic use, waterproof packaging of precision electrical parts, flameproof cable grommets for naval use, close-tolerance gas mask parts, instrument housings ...*

These wartime applications tell a story of thermoplastic versatility that has important implications for the designer and manufacturer. Certainly, your plans for an improved postwar product will call for the best plastic available. We suggest that you take advantage of the war experience data collected by our technical staff. It will show you what you can expect plastics to do for you, and most likely indicate how production costs can be lowered. Celanese Plastics Corporation, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N. Y.

LUMARITH* PLASTICS

MOLDING MATERIALS ... FILMS

FOILS ... SHEETS ... RODS ... TUBES

*Reg. U. S. Pat. Off.

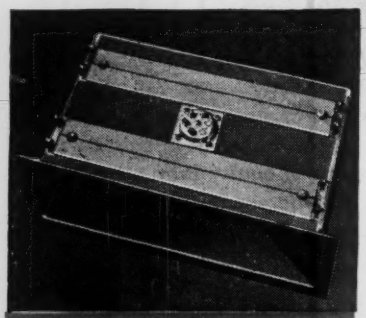
Select the thermostat that fits YOUR job

FROM THE WESTINGHOUSE COMPLETE LINE . . . THERE IS A CONTROL FOR ANY REGULATION PROBLEM . . .

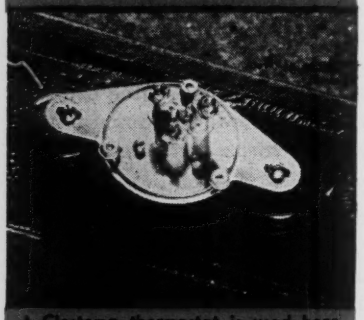
For control of electric heat up to 650 degrees you will find a Westinghouse thermostat with specialized characteristics to meet a complete range of requirements.

More than 6,000,000 thermostat temperature control units have been developed and applied in Westinghouse electrical devices alone. Westinghouse is the world's largest user of bi-metal for electrical control and protective devices . . . and all the design and application experience gained in decades of practice is passed on to you in Westinghouse thermostats.

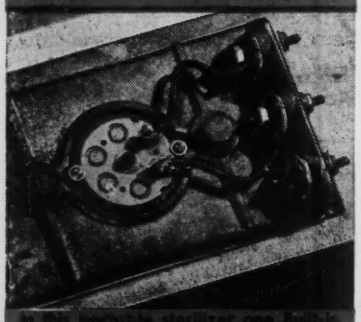
For more information on design and application ask for Booklet B-3344. You can get it through your Westinghouse office — or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-10287



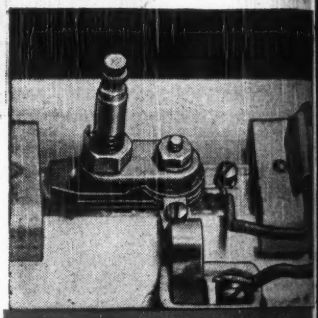
In this Tappan food container for aircraft, a Built-in Watchman keeps food at specified temperature.



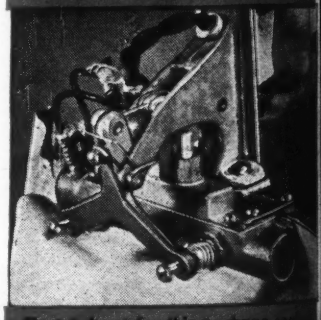
A Clostemp thermostat is used here to keep storage batteries from getting too cold or too hot.



In this portable sterilizer one Built-in Watchman maintains temperature, and a second one prevents burnout when water should boil dry.



Unitherm thermostat installed on [illegible] ing machine.



Electric heat for this package [illegible] machine is controlled by a [illegible] man thermostat.

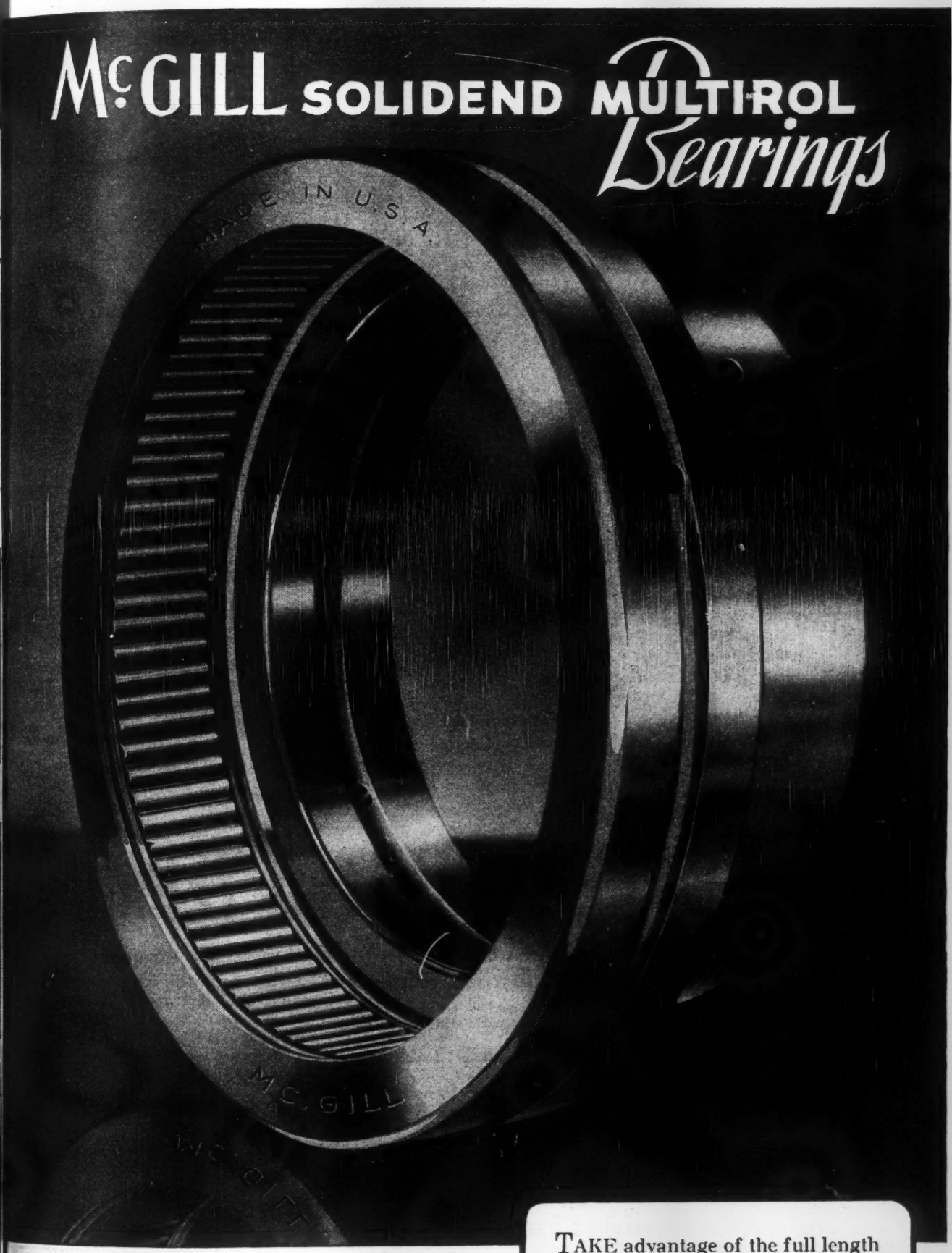
A Sentinel thermostat controls heat in this Westinghouse roaster.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

HEATING UNITS AND CONTROLS

McGILL SOLIDEND MULTIROL *Bearings*



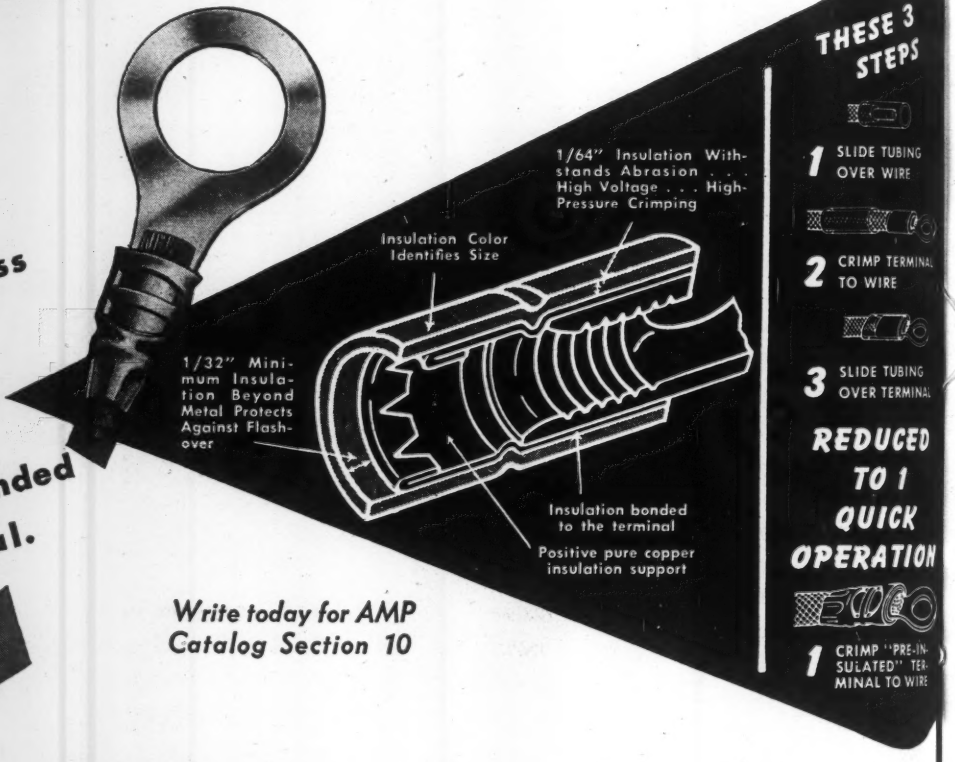
TAKE advantage of the full length rollers of McGILL "Solidend" *MULTIROL* Bearings. We will be glad to send you our catalog SM-42.

McGILL MANUFACTURING COMPANY, INC.
Manufacturers of Ball and Roller Bearings
VALPARAISO. INDIANA

FOR CRITICAL WIRING APPLICATIONS

AMP

The only solderless terminal with the insulation sleeving permanently bonded to the terminal.



THESE 3 STEPS

1 SLIDE TUBING OVER WIRE

2 CRIMP TERMINAL TO WIRE

3 SLIDE TUBING OVER TERMINAL

REDUCED TO 1 QUICK OPERATION

1 CRIMP "PRE-INSULATED" TERMINAL TO WIRE

Write today for AMP Catalog Section 10

The AMP PRE-INSULATED TERMINAL

Providing Revolutionary speed and accuracy in mass production wiring with superlative electrical properties.

PERFORMANCE CHARACTERISTICS

1. Terminals withstand a temperature of 350 degrees for 10 hours without physical damage to insulation or any deleterious effects on insulation.

2. Minimum breakdown voltage is 2500 volts D.C. in air at sea level; 800 volts D.C. at altitude of 30,000 feet.

3. Insulation does not support combustion when tested in accordance with ASTM D350-40T.

4. Insulating qualities are unaffected by long immersion of terminals in 10 per cent salt solution.

5. Water absorption of insulation is less than 1 ½ per cent.

6. The pre-insulation takes the exact contour of the crimp without distortion or cracking. It will not dry out or come loose.

7. Maximum electrical and mechanical properties of the AMP "Diamond Grip" Insulation Support Crimp assure vibration-proof connections. All three crimps made in one operation by AMP hand tools or press dies.

PRODUCTION ECONOMIES

THE INSULATION IS PERMANENTLY BONDED TO THE BARREL OF THE TERMINAL. The AMP Pre-Insulated Terminal is delivered to you ready to install with AMP precision hand, foot or power installation tools — thereby eliminating all stocking and handling of separate sleeving, and eliminating costly human error in its application. The cost of applying separate tubing to the terminal is approximately the same as the cost of applying the terminal itself to the wire.

Color identification of wire sizes clearly marked on terminals and tools.

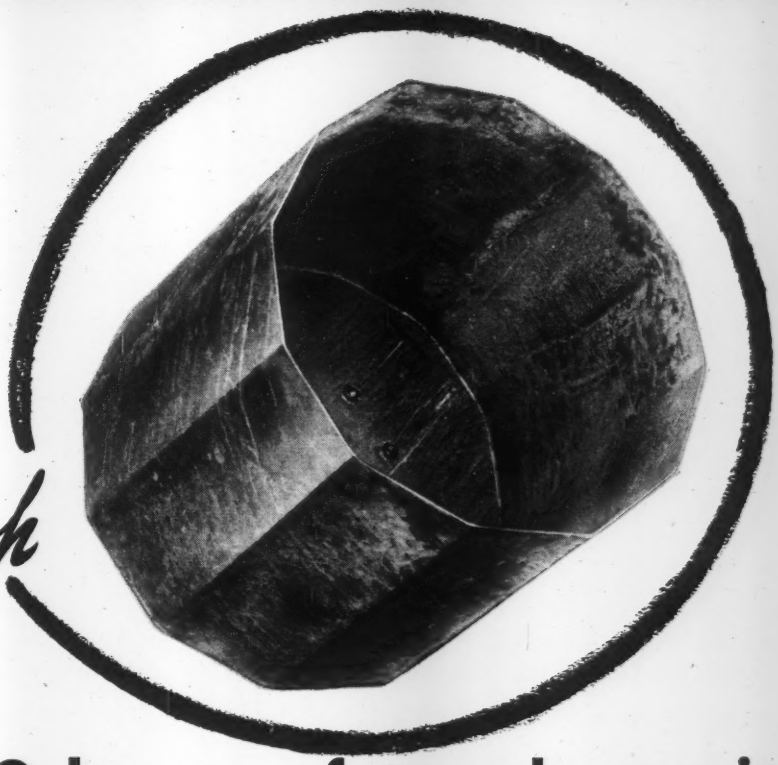
FOR SUPER PERFORMANCE USE THE SUPER AMP PRE-INSULATED TERMINAL

AMP

AIRCRAFT-MARINE PRODUCTS Inc.

1521-37 NORTH FOURTH STREET, HARRISBURG, PA.

In Canada: DAVID C. ORROCK, 1405 BISHOP STREET, MONTREAL, QUEBEC
F. N. ADAMS, 726 HOMER STREET, VANCOUVER, BRITISH COLUMBIA



Proof enough

...in 50,000 hours of tough service

The Independent Nail & Packing Company of Bridgewater, Mass., "Manufacturers of Special Wire Nails", was plagued with tumbling barrel trouble in the plating room—up until seven years ago. This is the way Mr. H. James Stone tells the story:

"A little over seven years ago we installed our first Everdur oblique tumbling barrel in our plating room. Prior to that time we had been using wooden barrels and composition cast brass barrels, neither of which gave us good service. Wooden barrels wore out very quickly on sharp work like ours, and composition barrels were attacked by the strong acid and alkaline solutions which we use in our cleaning and polishing process.

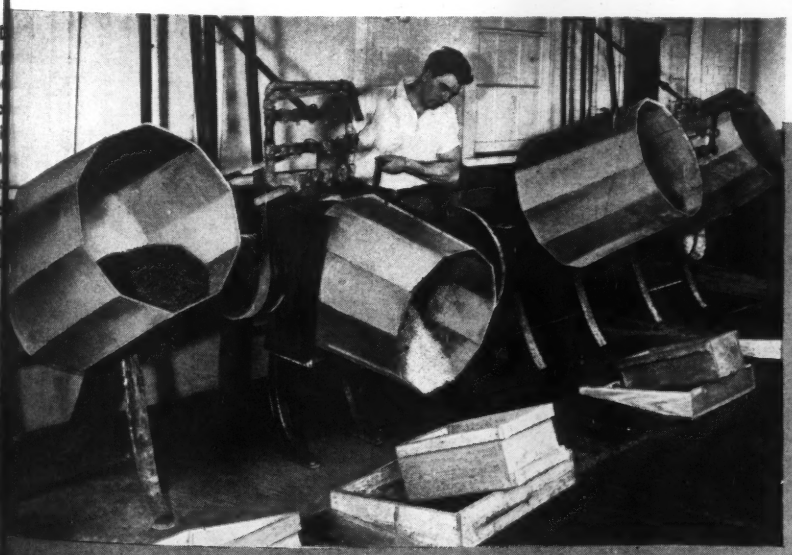
"Since 1937 we have installed an entire battery of Everdur barrels and now have additional barrels in process of construction. We are glad to tell you that our first Everdur barrel which was installed in the spring of 1937 gave us seven years of satisfactory service, in practically continuous operation 24 hours a day, tumbling our work in preparation for electroplating. The barrel was filled with the various acid and caustic solutions customarily used in plating rooms. Considering the large tonnage handled, we are greatly pleased with its long life."

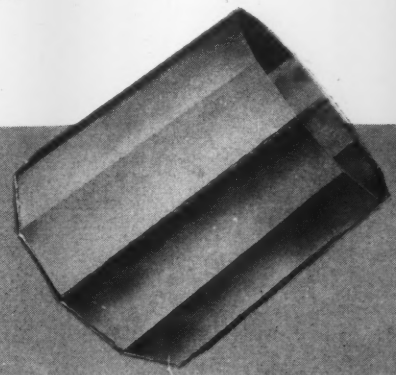
Thank you, Mr. Stone. Other reports in our files tell a similar story—that tumbling barrels made of Everdur* Metal give long, economical service. 45160

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

*Reg. U. S. Pat. Off.





Top of page: Unretouched photograph of Everdur tumbling barrel after 7 years of almost continuous operation. ***Above:*** Oblique tumbling barrel fabricated of ¼" thick Everdur Metal by Massachusetts Engineering Co., Inc., North Quincy, Mass. The three sections are joined by carbon arc welding with Everdur welding rod. *Left:* Everdur barrels in the plating room of Independent Nail & Packing Company.

ANACONDA

Everdur Copper-Silicon Alloy

TIMED LIGHTNING

at the rate of 36,000 sparks a minute

This Bendix-Scintilla Aircraft Magneto is capable of producing 36,000 timed sparks a minute to the engine of a modern fighter. Product of Scintilla Magneto Division, Bendix Aviation Corporation.

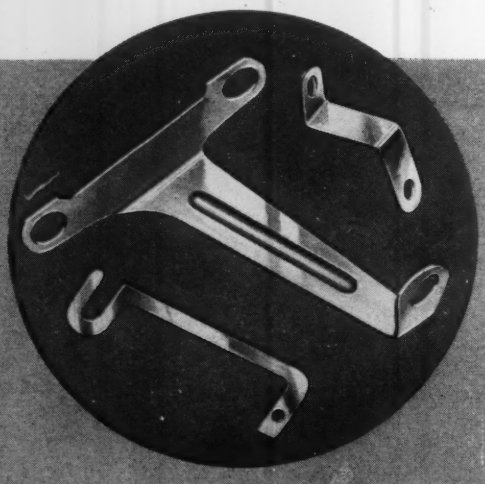
Nowhere in aviation are metals called on to do a tougher job per unit of weight than in Bendix-Scintilla Aircraft Magnetos, Ignition Harnesses and Switches.

It is no coincidence that many of the metals used in this inseparable trio are supplied by The American Brass Company, for Anaconda Alloys are not newcomers to aviation. They have played an important part ever since the first flight across the Atlantic . . . across the Pacific . . . around the world.

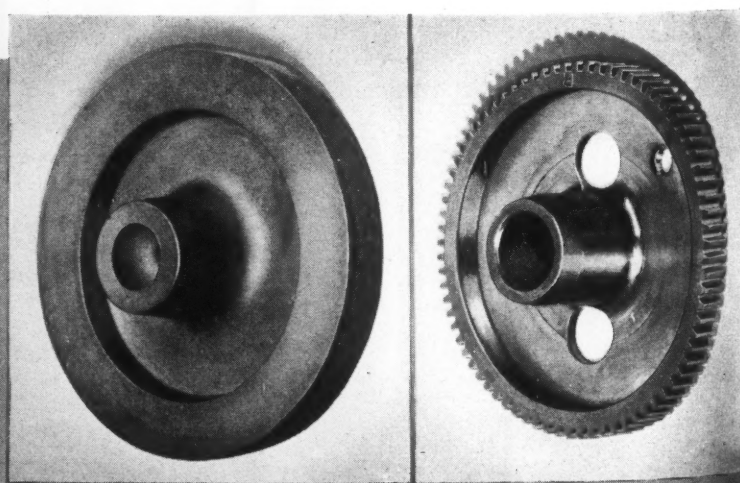
The high standards of war-paced aircraft engineering depend on Anaconda Alloys for hundreds of special-purpose applications. Two of these are described here . . . *all* perform their assigned task ably and dependably.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*



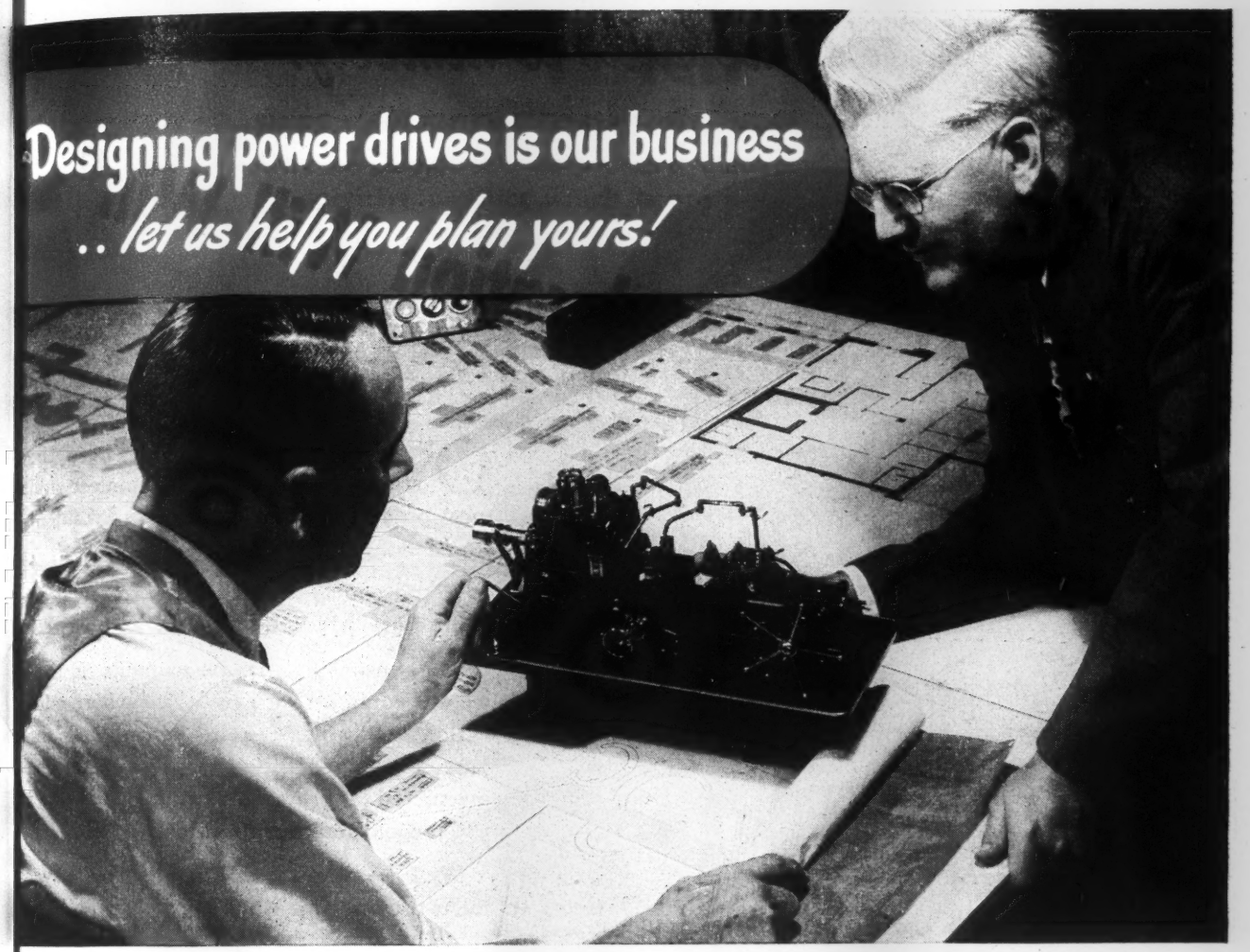
Above: Electrical contacts of Beryllium Copper. This Anaconda Alloy can be worked in the soft annealed state, then strengthened and hardened by heat treatment. It possesses excellent spring properties, high tensile strength and endurance limit, in combination with good electrical conductivity.



Above: Magneto timing gear machined from hot pressed Avialite* forging. This aluminum bronze alloy, developed by The American Brass Company is strong, tough and highly resistant to corrosion. *Reg. U. S. Pat. Off.

ANACONDA

Anaconda Copper & Copper Alloys

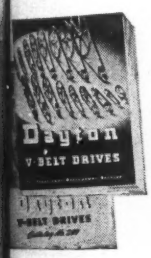


Take full advantage of the years of experience Dayton Power Transmission Engineers have had planning new and more efficient power drives . . . developing new and better V-Belts that will deliver every bit of power from the driver to the driven unit efficiently, quietly, continuously.

This experience can be of real help to you because the performance of that new model machine you are designing will depend in great measure on the power drive you specify for it. You can insure its efficient performance by letting a Dayton Power Transmission Engineer work with you when you get to the point of planning the power drive.

His own years of experience are backed by 40 years' research in working with natural and synthetic rubbers. It's experience that, combined with your own specialized knowledge, will make certain that your brainchild will prove completely successful when finally produced and placed in the hands of the user. This experience will be put at your disposal gladly, and without obligation. Write for full information.

THE DAYTON RUBBER MANUFACTURING COMPANY
DAYTON 1, OHIO
THE WORLD'S LARGEST MANUFACTURER OF V-BELTS



Free To Design Engineers

Catalog 280, a 384-page encyclopedia of V-Belt information listing millions of power drive combinations. Catalog 150 gives you complete information on fractional horsepower V-Belt drives. Write today for your copies of both catalogs.

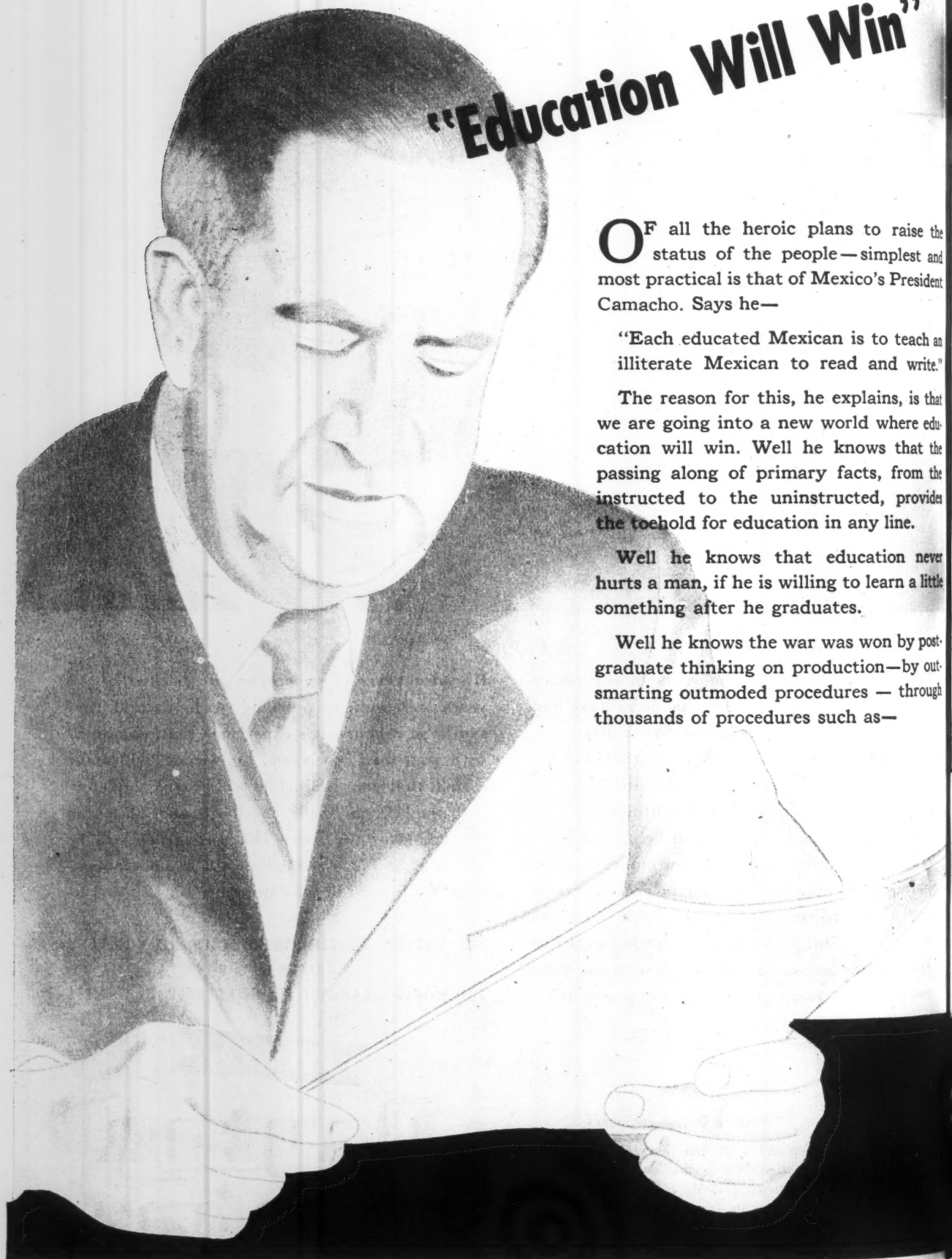
V-Belts by

Dayton Rubber

THE MARK OF TECHNICAL EXCELLENCE IN SYNTHETIC RUBBER

then he said to himself:

"Education Will Win"



OF all the heroic plans to raise the status of the people—simplest and most practical is that of Mexico's President Camacho. Says he—

"Each educated Mexican is to teach an illiterate Mexican to read and write."

The reason for this, he explains, is that we are going into a new world where education will win. Well he knows that the passing along of primary facts, from the instructed to the uninstructed, provides the toehold for education in any line.

Well he knows that education never hurts a man, if he is willing to learn a little something after he graduates.

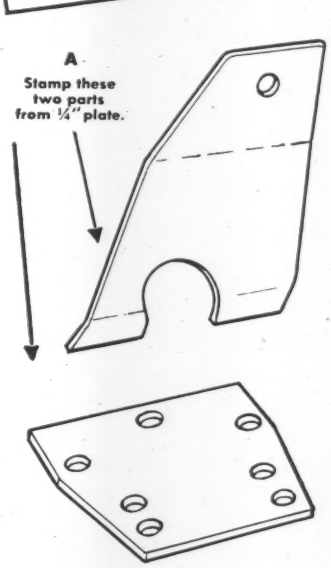
Well he knows the war was won by post-graduate thinking on production—by outsmarting outmoded procedures — through thousands of procedures such as—

"TEACH"—*he says*

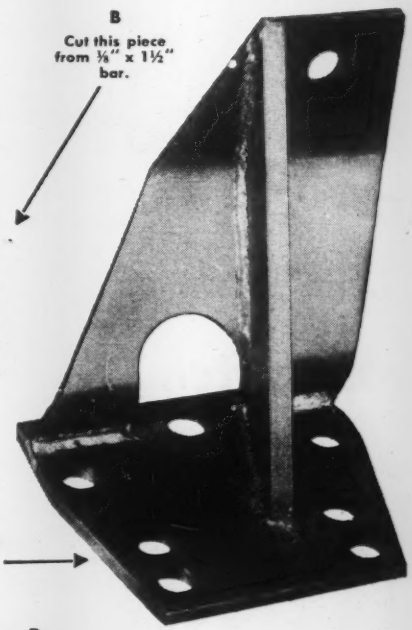
HERE, PRESIDENT CAMACHO, is education for any man who wonders why he cannot sell his product, made by outdated procedures, against a competitive product which is arc welded *and come out with a profit.*

The A-B-C's of Welded Design

COSTS $1.24



COSTS 64c



RESULT: Saves 60c each

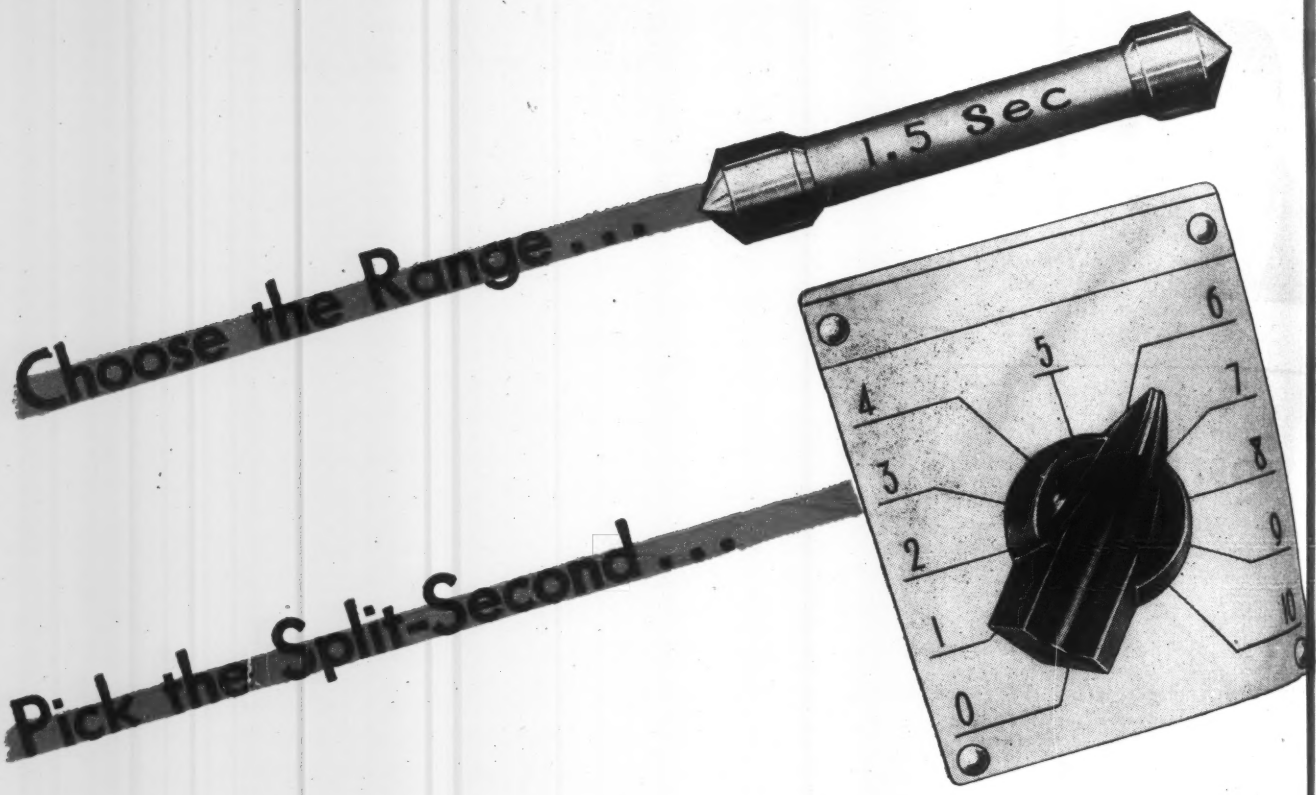
THIS bracket is typical of many parts being changed over to welded design to cut costs, and to produce a stronger, more rigid and lighter product . . . one that can be constantly improved easily and quickly.

Here is the A-B-C solution to many of your problems of today. The Lincoln Engineer will gladly help you get the results *you* want. Studies in Machine Design free on request. Ask for them on your business letterhead.

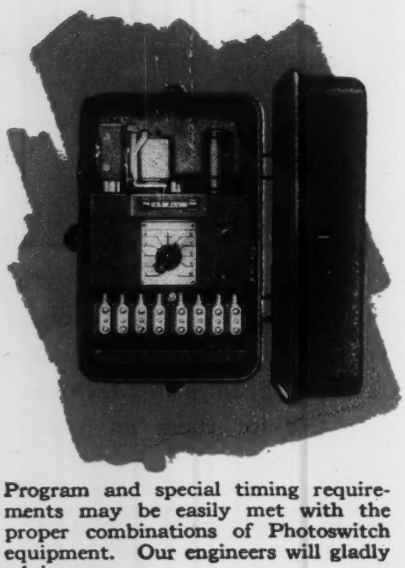
THE LINCOLN ELECTRIC COMPANY • Dept. F-1 • CLEVELAND 1, OHIO

America's greatest natural **recourse**

ARC WELDING



Photoswitch ELECTRONIC TIMER *does the rest!*



Program and special timing requirements may be easily met with the proper combinations of Photoswitch equipment. Our engineers will gladly advise you.

For any Timing Control purpose, demanding split-second accuracy and unfailing operation, Photoswitch Electronic Timer has been proved best by repeated tests. Electronic in operation, Photoswitch Timer has only one moving part and is guaranteed for maintenance-free operation and unlimited life.

Its wide timing range — from 1/20th of a second to two minutes — and split-second adjustability to any fraction of time within that range have resulted in Photoswitch Timer being adopted as standard in many diverse industries.

It is simple to operate. The correct one of six interchangeable timing elements is selected to determine the timing range, the dial is set to the required split-second interval within that range. Flexible in operation, it provides for three different methods of timing: initiation of the timing interval by momentary contact, timing throughout sustained contact, or delayed action following contact.

Photoswitch Timer, because of its precision and long life, has no equal for continuous repeat cycle timing, or short interval timing.

In repeated tests by leading equipment manufacturers, Photoswitch Electronic Timers have been selected on the basis of accuracy, versatility, long-life and trouble-free maintenance. They can do a job for you.

Other Photoswitch equipment control levels, turbidity, smoke density indication, counters and conveyors, inspection, property and machinery safeguards and similar industrial applications. Our engineers are available to assist you on any special control problems for which electronics may offer a possible solution.

PHOTOSWITCH INCORPORATED

CAMBRIDGE 42, MASSACHUSETTS *District Offices in All Principal Cities*

PHOTOELECTRIC AND ELECTRONIC CONTROLS FOR EVERY INDUSTRIAL PURPOSE

Saginaw

BALL-BEARING SCREW AND NUT

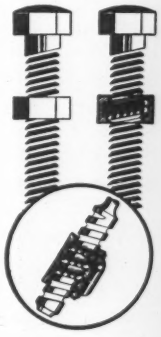
IS RIGHT FOR THE APPLICATION

The Saginaw Recirculating Ball-Bearing Screw and Nut brings new ease, accuracy and efficiency in screw thread operations of raising or lowering, opening or closing, extending or retracting. Working on the principle of rolling balls inserted between the threads of the nut and the screw, it results in efficiencies to 90% and over.

The Saginaw Ball-Bearing Screw and Nut can be operated manually or by power, with the operating force applied to either the screw or the nut. Designed for a wide range of sizes, its fields of application are practically unlimited. It has been successfully applied to retracting airplane landing gears and to the movement of wing flaps on planes. It can be applied to the lowering of a car door window or to milling machines and lathes as a lead screw, a jack or a control mechanism.

BUY VICTORY BONDS

This friction-free unit is a companion product to the proven recirculating ball-bearing steering gear now universally used in cars and trucks. You may have a problem which the Saginaw Ball-Bearing Screw and Nut can solve. Our engineering department will be pleased to give it special attention.



THE PRINCIPLE—In the ordinary nut and bolt, power is consumed by friction caused by the threads riding on each other (left). To ease friction and thus decrease actuating effort, Saginaw Steering Gear devised a means of inserting bearing balls between the threads connecting the nut and bolt (right), and developed a method of permitting the balls to recirculate through a special raceway. Freedom from friction permits greater speeds without excessive heat generation . . . reduces operating cost as much as two-thirds.

Saginaw Steering Gear

DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN.

MANUFACTURER OF STEERING GEAR ASSEMBLIES • STEERING LINKAGE ASSEMBLIES • PROPELLER SHAFTS • DIESEL ENGINE AND AIRCRAFT PARTS

This Is Our Problem

One logical first step when an oil seal is needed is to look into a catalog. But in the case of seals, it is not the way to be sure of getting the seal that will exactly meet the sealing conditions.

Every oil seal problem is an individual case. It needs to be analyzed on a scientific basis and solved individually as an engineering situation.

That is how we go about it here at Milpaco. As Lubricant Sealing Specialists, we first study your proposed application in terms of tolerances, temperatures, pressures, and particular operating conditions. From this study we formulate specifications for a seal that will meet the requirements. Then we build that seal especially for your needs.

Call us in as Lubricant Sealing Consultants and Manufacturers of Oil Seals to solve your problems adequately and efficiently.

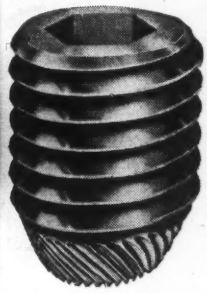
MICHIGAN LEATHER PRODUCTS COMPANY
6111 LAFAYETTE AVE., EAST DETROIT 7, MICHIGAN

Designers and Manufacturers of
Oil Seals and Mechanical Leather Packings

SOCKET SCREWS by UNBRAKO

Reg. U. S. Pat. Off.

MAKE DESIGNING EASY



Pat. & Pats. Pending

You can count on better, more compact designs when you specify "Unbrako" screws. The internal wrenching feature saves SPACE for you, since the wrench fits within the socket rather than around the head. And the great tensile strength of the "Unbrako" Socket Screws permits the use of smaller, and frequently fewer screws . . . thus saving WEIGHT.

The Knurled Point of the "Unbrako" Socket Set Screw (above) makes it an absolutely dependable Self-Locker. Knurling of the point holds it secure by digging-in firmly whenever vibration tries to shake it loose. Even so, it can easily be backed-out with a wrench and used over and over.

The Knurled Head of the "Unbrako" Socket Head Cap Screw (center) speeds production by preventing finger-slip and lost motion. Even oily fingers get a grip on it—turn it farther and faster before a wrench is needed.

Where the "Unbrako" Knurled Point Socket Set Screw cannot be used, our Knurled Thread "Unbrako" (bottom) will be found a dependable and satisfactory Self-Locker, regardless of the style of point. The knurls positively prevent the screw from unwinding.

All screws available in sizes from No. 0 to 1½" diameter — full range of lengths. Send for our informative "Unbrako" Catalog.

Knurling of Socket Screws originated with "Unbrako" years ago.

Pat'd

OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 102

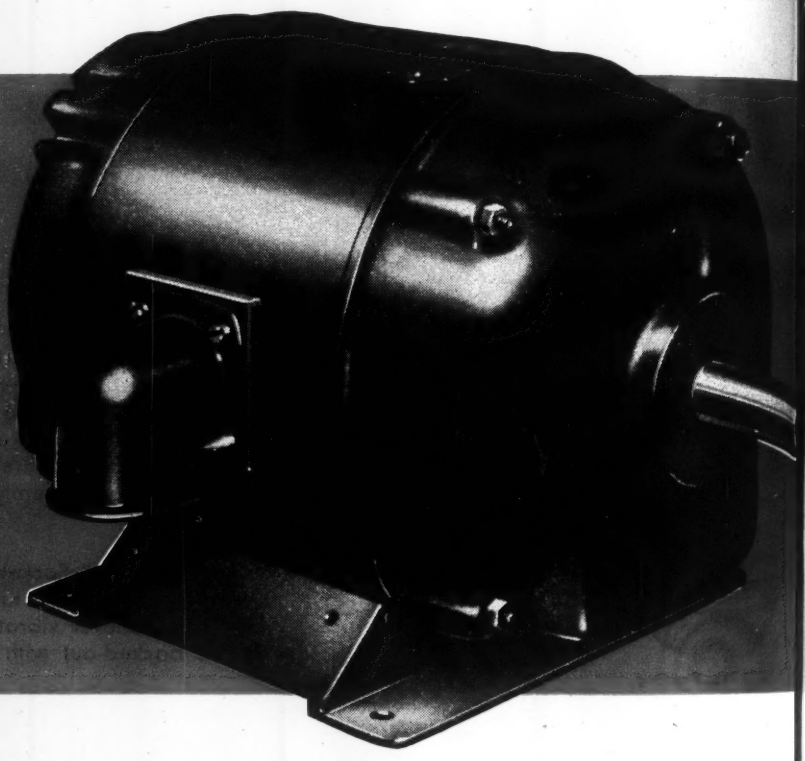
—— BRANCHES ——

BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO

NOW AVAILABLE

at no extra cost to you.

NEW *Protected* HEAD *Uni-Shell* MOTOR



Are you building or preparing to build machines on which electric motors may be exposed to dripping liquids, grease contamination, falling objects, or any kind of mechanical injury from above? If so, here's the answer to your problem.

R & M Uni-Shell Motors—long recognized for uniform *interchangeability* of all types in any one frame size (a big designer help in itself)—now offer uniform *protection* as well.

In polyphase, single phase, and DC types, these Protected Head Motors contain no trouble-inviting vertical openings. Standard open motors, in fully sealed ball-bearing construction, provide drip-proof protection at no increase in price. Sleeve-bearing motors can be made drip-proof by the addition of cover plates to standard Uni-Shell heads without increase in length, hub to hub.

Get all the facts, first hand, on this brand-new line of Protected Head Uni-Shell Motors by writing the Motor Division for your copy of Folder 1904, today. On your business letterhead, please.

FREE NEW BOOKLETS!

"SHADED POLE MOTORS," Form No. 1887. "MATCHED MOTOR PARTS," Form No. 1871. "UNI-SHELL INTEGRAL H.P. MOTORS," Form No. 1845. "MOTOR GENERATOR SETS," Form No. 1881.

Send for any or all of these booklets, now.

ROBBINS & MYERS • INC. MOTOR DIVISION • SPRINGFIELD, OHIO

In Canada: Robbins & Myers Co., of Canada, Ltd., Brantford, Ont.

MOTORS • HOISTS • CRANES • MACHINE DRIVES • FANS • MOYNO PUMPS • FOUNDED 187

IF YOU ARE INTERESTED IN

the economical transmission of power...

. . . you will want copies of these books!

ulletin UPA for the first time gives gineering data on a newly developed pproach to power transmission. In is bulletin are shown compact Power nits. These "packages of power" as- re absolutely correct mounting of ears, so essential to efficient opera- on, particularly when the gears are high precision. Their design incor- orates "A-Q" gears, described below.

Bulletin AQA gives complete engi- eering information on the design and pplication of "A-Q" (aircraft quality) ears. These new gears assure greater echanical efficiency, longer life, ighter weight, more compact design nd quieter operation.

These gears embody advance techniques in design and manufacture that permit operation at higher speeds and make possible loadings far in excess of values customarily considered safe design. By incorporating them in the machines you manufacture, your engineers may be able to solve difficult problems now confronting them—may be able to improve the performance of these machines and may be able to reduce over-all costs.

These books should be in the hands of every designing engineer or manufacturer interested in equipment requiring the transmission of power. Check the coupon and mail it today.

OOTE BROS. GEAR AND MACHINE CORPORATION • 5225 South Western Blvd., Chicago 9, Ill.

Foote Bros. Gear and Machine Corporation
Dept. O, 5225 S. Western Blvd.
Chicago 9, Ill.

Gentlemen:
Please send me Bulletins checked below.

- ☐ Bulletin UPA on Foote Bros. Power Units
- ☐ Bulletin AQA on Aircraft Quality Gears

Name.....

Position.....

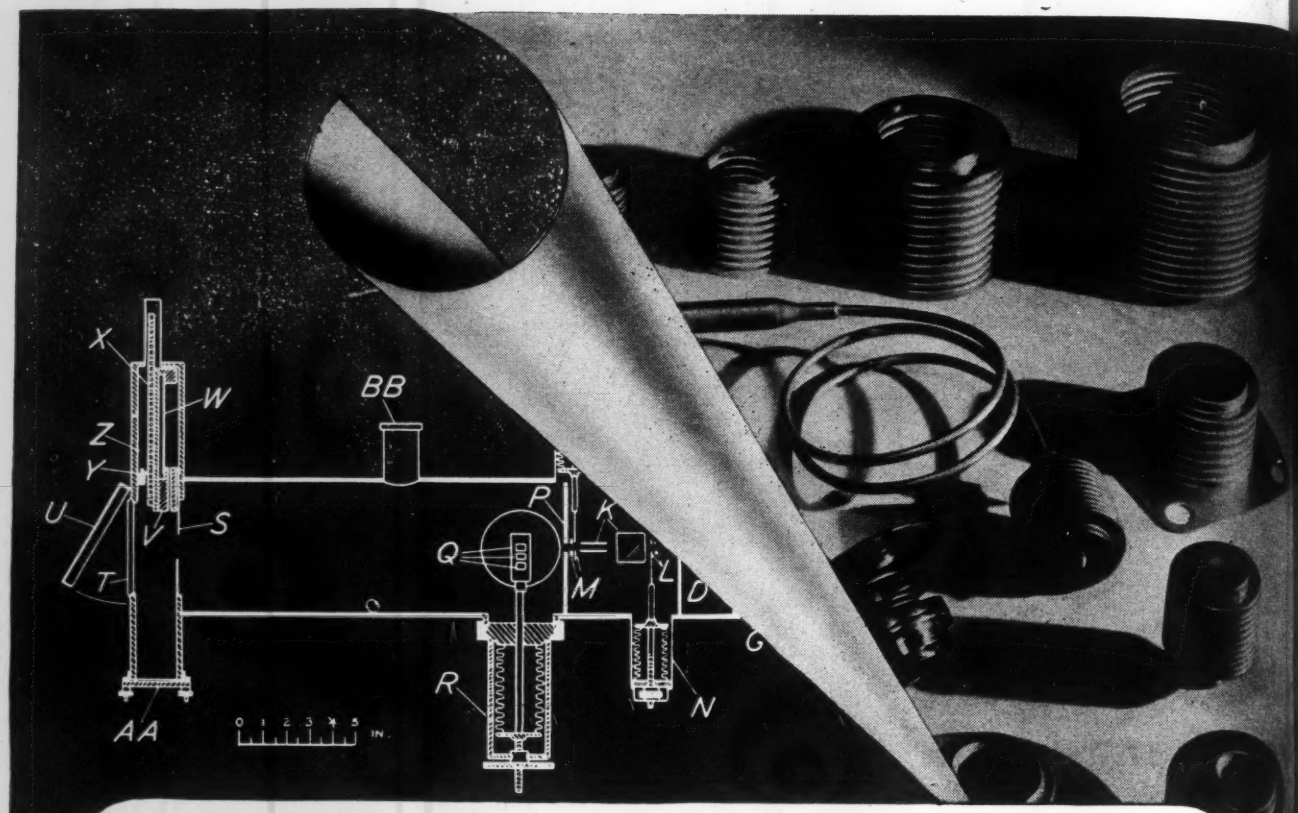
Firm.....

Address.....

City.....*State*.....

FOOTE BROS.

Better Power Transmission Through Better Gears



POST-WAR PLANS REALIZED!

SUCCESS IN ADVANCE . . . right now the future of many post-war products is being assured *well in advance* . . . For today more and more manufacturers are saying: "*Let's get in touch with Bridgeport Thermostat; let's incorporate Bridgeport bellows assemblies in our new designs.*"

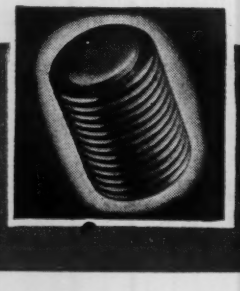
What is the result?

First, Bridgeport Thermostat engineers study Mr. Manufacturer's proposed product . . . specify the size and type of bellows and bellows assembly required, basing their recommendations on exact operating conditions.

Next, the manufacturer, acting on Bridgeport Thermostat's report, either buys bellows and completes his assemblies in his own shop or has Bridgeport do the entire job. If he does the latter he receives bellows assemblies on schedule, built to exact specification . . . ready to install . . . *usually at a cost much lower than would have been possible in his own plant.*

Yes, Bridgeport technique is the secret ingredient in countless devices which will amaze the post-war world with their ingenuity and efficiency.

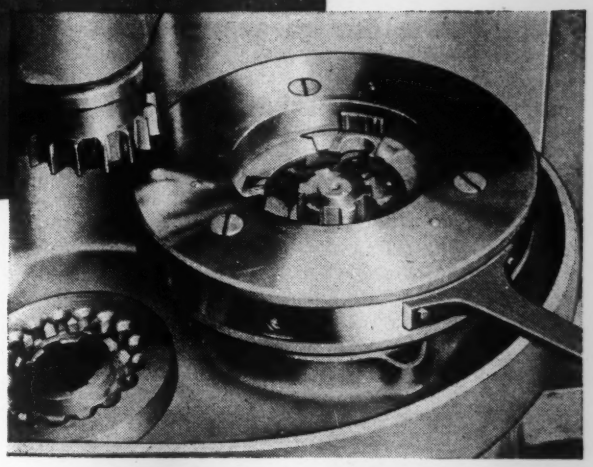
Write for Bulletin VK-100. It contains information of interest to everyone concerned with design and production of mechanical devices.



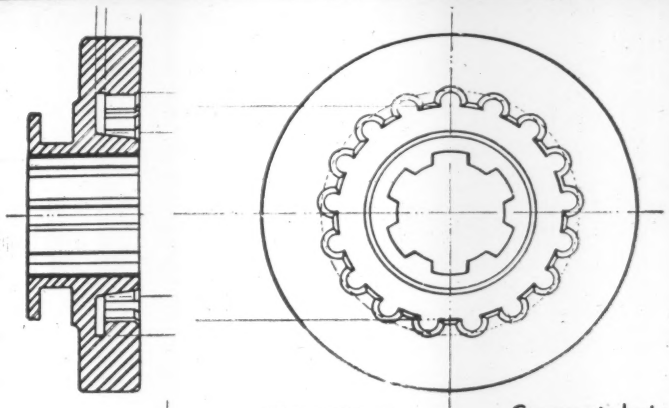
Bellows Assemblies . . . Bellows . . . Bellows Devices

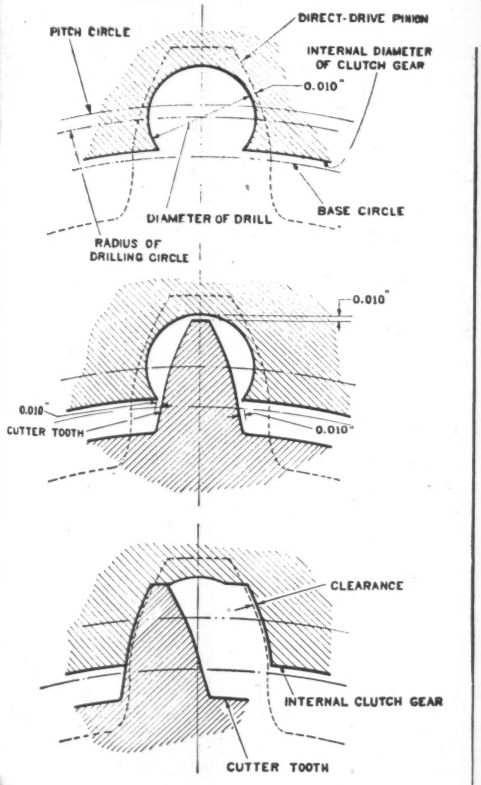
BRIDGEPORT THERMOSTAT COMPANY, INCORPORATED—BRIDGEPORT 1, CONN.

PROJECTING HUBS or EXTENDED RIMS No Problem to Accurate Tooth Forming ...for a SIDE-TRIMMING FELLOWS GEAR SHAPER



Close view of a 7-type Fellows Side-Trimming Gear Shaper cutting internal teeth for an automobile transmission clutch gear.





Progressive stages in the cutting of an internal clutch gear as illustrated above. The Side-Trimming Cutter alternately cuts corresponding sides of the teeth.

Compact design requirements sometimes dictate the need for cutting precision external or internal gear or clutch teeth close to a projecting hub or inside an extended rim, where conventional types of cutters and machines cannot be employed.

To accomplish such work, Fellows makes a Side-Trimming Gear Shaper and special side-trimming cutters. The cutter has the same number of teeth, which are also the same shape as the clutch teeth. The cutter teeth are made thinner than the required width of the tooth spaces, so that the cutter will enter the previously drilled holes, as illustrated.

The cutter- and work-spindles do not rotate, but an oscillating motion is imparted to the cutter-spindle, so that the cutter teeth alternately cut the corresponding sides of the teeth. This operation progresses until the tooth spaces are machined to the desired width, when the machine stops automatically.

The accompanying diagrams are indicative of the nature of such work. Our engineers will be glad to work with you in solving your gear or other related problems. Write: The Fellows Gear Shaper Company, Springfield, Vt., or 616 Fisher Building, Detroit 2, or 640 West Town Office Building, Chicago 12.

Fellows

THE FELLOWS METHOD...MACHINES AND TOOLS FOR ALL OPERATIONS FROM BLANK TO FINISHED GEAR

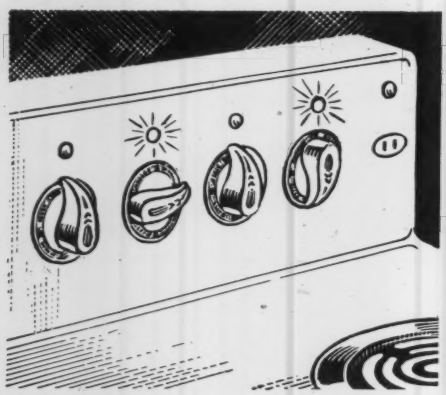
Design Idea

to help you sell your POSTWAR PRODUCT

QUICK visual indication is a sales advantage for hundreds of products. And G-E Neon Glow Lamps have outstanding qualities as indicators. Use them on home appliances, wiring devices and industrial electrical equipment!

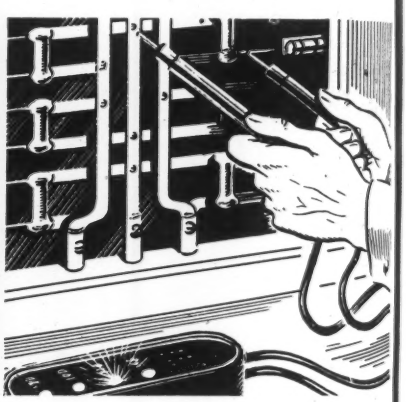
CHECK THESE UNIQUE FEATURES OF G-E NEON GLOW LAMPS

1. Distinctive orange red glow, needs no cover glass.
2. Dependable long life—rated at 3000 hours.
3. Very low current consumption.
4. Variety of sizes and wattages.
5. High resistance to vibration and shock.
6. Usable on AC or DC circuits.
7. Work on regular 105-125 volt circuits without the use of step-down transformers.
8. Practically no heat.

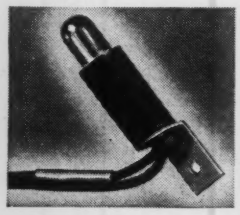


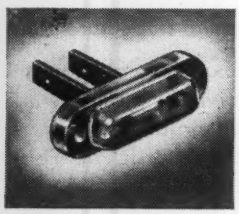
HOME APPLIANCES . . . Build more usefulness into your appliances. G-E Glow Lamp gives instant visual indication that range units are on. Other applications: waffle irons, electric irons, roasters, heating pads.

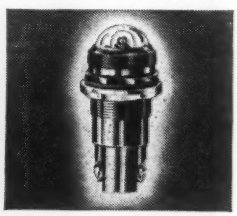
WIRING DEVICES . . . No fumbling in the dark to find the light switch if it has a G-E Glow Lamp. When lights are off, the glow lamp is a highly visible indicator as to location of the light switch.



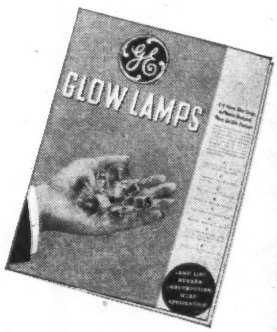
INDUSTRIAL EQUIPMENT . . . G-E Glow Lamp in voltage tester can be used to indicate polarity, frequency, DC or AC, as well as voltage. Other uses: exit indicators, fire alarm stations, panelboards.







THESE ARE TYPICAL EXAMPLES of indicator light assemblies made by several manufacturers to house G-E Neon Glow Lamps. For names of these manufacturers, write to the address below.



FREE! New folder describes typical uses for G-E Neon Glow Lamps and gives lamp data. Write address below.

GENERAL ELECTRIC

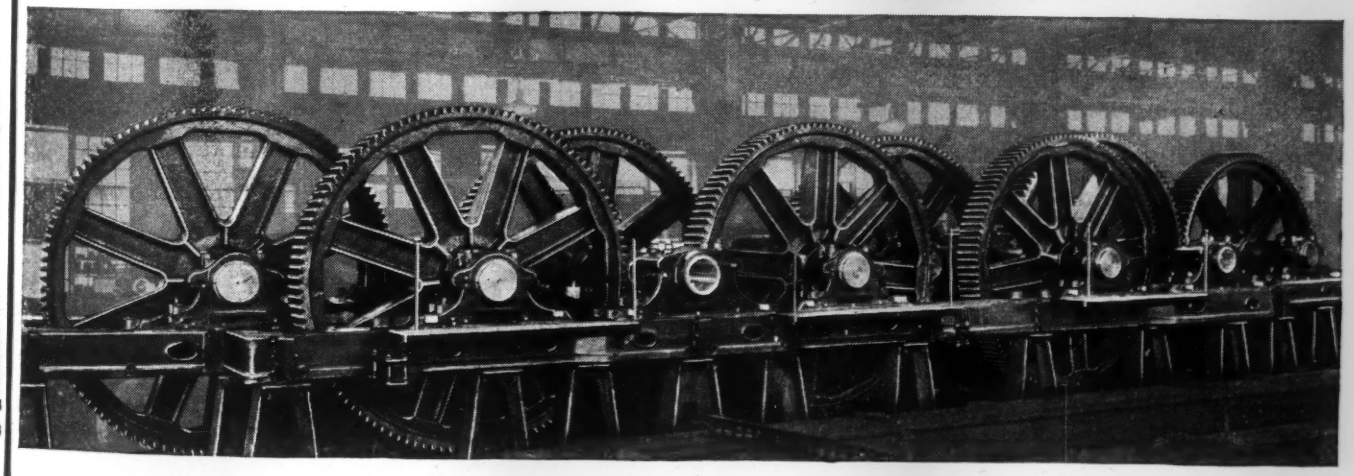
1 Newark Street, Hoboken, N. J.

CONTINENTAL
STEEL CASTINGS

Heavy mill gears cast by Continental—12 feet in diameter and each weighing 20,000 pounds form the gear train shown below.

Continental carbon and alloy steel castings, recognized for dependability, are the result of production "know how" and continuous research for improved castings.

Other Continental products include rolls, rolling mill equipment and special machinery.



CONTINENTAL FOUNDRY & MACHINE COMPANY

CHICAGO • PITTSBURGH

CHICAGO WORKS, EAST CHICAGO, INDIANA

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Small Difficult Parts

Regardless of Specifications

are "IPCAST BABIES"

IPCAST is a new fabricating technique for quantity production of small metal parts having rigid specifications. Ipcast parts with their previously impossible specifications, open new avenues for expansion of design.

All in a day's work for Ipcast is the production of small parts calling for metals hard or impossible to machine—close tolerances—plain and intricate contours—weights from a fraction of an ounce to one-quarter pound. The Ipcast field starts where metals, tolerances and finishes prohibit the use of ordinary methods.

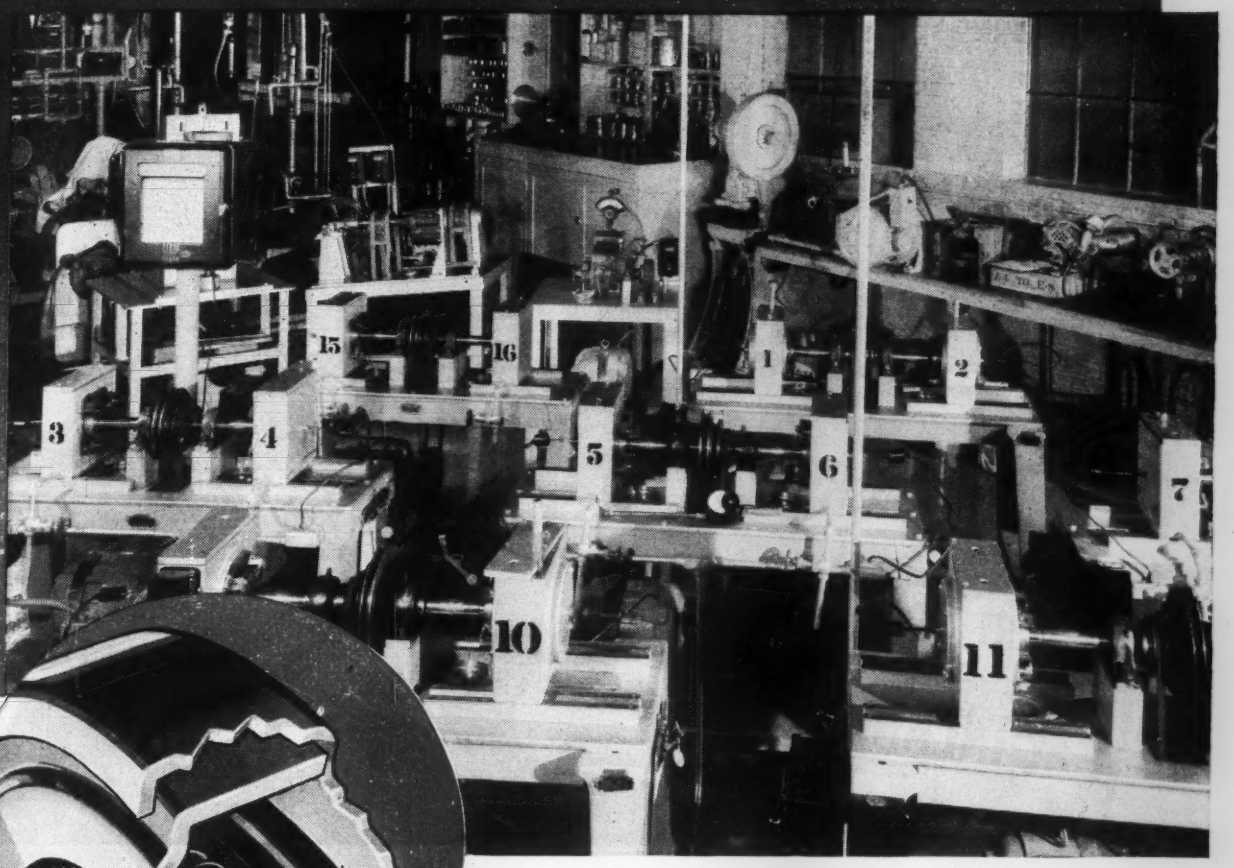
IPCAST

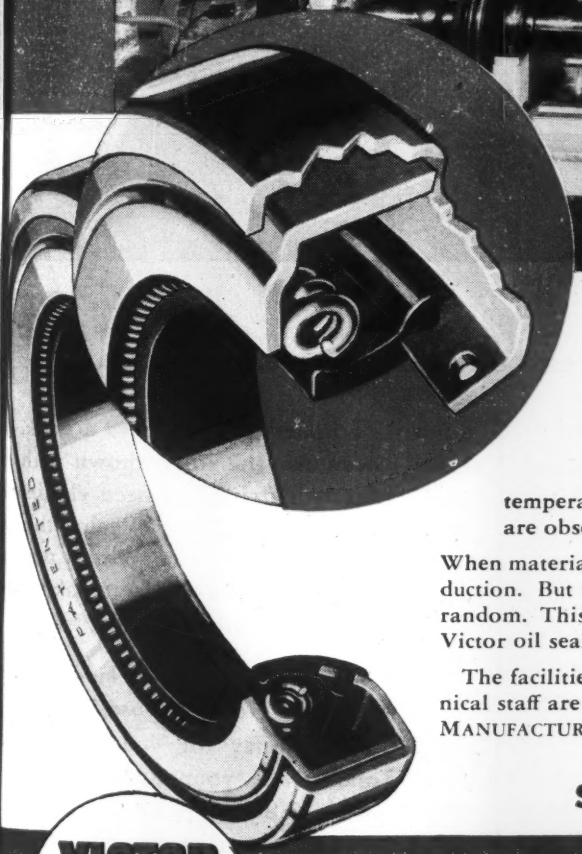
If a part cannot be economically produced to your requirements by machining, pressure die casting, forging, screw machine or punch press, we suggest sending us a detailed drawing with complete specifications on metal, tolerances, finish, yearly volume and rate of delivery. Be sure to include an actual sample of the part. Address all inquiries to Dept. A.

ILLINOIS precise CASTING COMPANY

[illegible] SIXTEENTH ST., CHICAGO 6, ILL.

Developed through research





. . . Controlled in production

Shown above is a section of Victor's laboratory devoted to the development and testing of oil seals. Units of the machines for which Victor seals are engineered are set up in this testing laboratory. Each seal design is carefully checked under conditions which simulate the actual job to be performed; shaft speeds, eccentricity, misalignment, lubricant temperature, and lubricant pressure are carefully duplicated. The seals on test are observed for thousands of hours to determine life performance.

When material and design have been approved, the seals are put into quantity production. But the testing goes on continuously, from production samples selected at random. This production control assures maintenance of the high quality of all Victor oil seals.

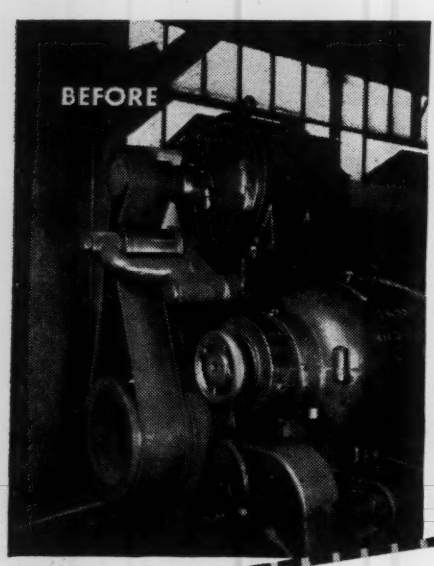
The facilities of this laboratory and the services of a competent, experienced technical staff are at the disposal of any manufacturer with a sealing problem. VICTOR MANUFACTURING AND GASKET COMPANY, P. O. Box 1333, Chicago, Illinois, U. S. A.

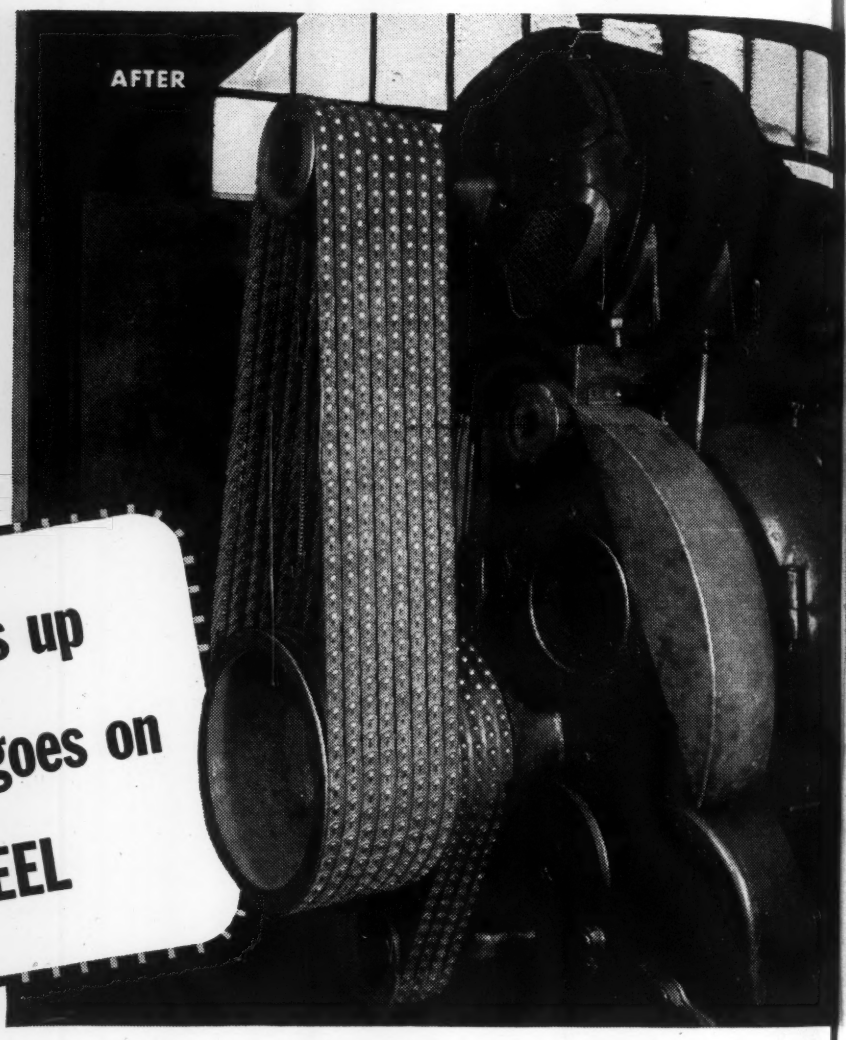
SEALING PRODUCTS *Exclusively*

VICTOR
GASKETS AND OIL SEALS
SEALING PRODUCTS THROUGH RESEARCH

VICTOR

GASKETS • • OIL SEALS





Production goes up when VEELOS goes on at INLAND STEEL

Belt Slippage Ended . . . Lathe Takes Cut Almost Twice As Deep

The "Before and After" Story of a Belt Drive. The photograph at the left shows a flat belt drive on a Libby Turret Lathe at the Inland Steel Company; the photograph at the right shows turret lathe after replacement of flat belt with Veelos. Idler has been eliminated . . . belt slippage has been ended . . and the lathe now takes a cut almost twice as deep as before.

Link Construction Ups Production

WHEREVER Inland Steel Company has installed Veelos, machine production has increased.

Veelos—the adjustable V-belt—has demonstrated its unquestionable value to Inland department heads. For example, consider the drives shown in the "before and after" photographs of the Libby Turret Lathe. The former flat belt drive constantly slipped. Veelos ended this slippage completely. In fact, *these Veelos drives have not even been readjusted since their installation in May, 1944.* Yet these drives operate 24 hours a day, 6 days a week. A need for the idler shown with t flat belt drive has been eliminate And, equipped with Veelos, this tu ret lathe takes a cut almost twice deep as it was able to take wh equipped with flat belt.

In Every Type of Industry, Veelos Helps Increase Production

Write today for your free Veel manual as your first step towa using Veelos. A single drive w convince you of the advantages Veelos . . . just as Inland has be convinced.

VEELOS
THE LINK
V-BELT
Adjustable to any Length
Adaptable to any Drive

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PA.

BOTH are Permite Castings. The one pictured at the top was cast in sand, and weighs 4 lbs. 6 oz. The other is a permanent mold casting of the same part, and weighs only 3 lbs. 10 oz. Because the initial order called for a limited quantity, sand castings were supplied. But later orders, in greatly increased quantities, justified a change to permanent mold.

The Permite customer gained the saving of lighter weight per casting, and the other advantages that obtain when the quantity and the nature of the casting design permit the use of permanent molds.

Close tolerances in the casting process are achieved with Permite permanent molds. There is less "dead" metal to pay for and to remove by machining. Uniformly accurate dimensions mean faster machining, faster production, lower production costs.

Permite modern foundries are equipped to give you high quality aluminum alloy castings of the type which best meets your needs. Prepare for increasing postwar competition by consulting with Permite engineers on your castings requirements. Your inquiry will receive prompt attention.

PERMITE

ALUMINUM INDUSTRIES, Inc.
CINCINNATI 25, OHIO

Detroit: 809 New Center Building
Chicago: 616 South Michigan Ave.
New York: 9 Rockefeller Plaza
Atlanta: 413 Grant Building

PERMITE ALUMINUM ALLOY CASTINGS

How to buy Improved Steel Castings

War experience has taught us a lot of things of value to you.

For instance—how to make steel castings that meet exacting Army and Navy tests for Soundness, for clean, smooth Finish, for precise Dimensions.

And how to deliver, within narrow limits, the metallurgical properties demanded by the end use.

This broadened experience, plus new equipment and new techniques in the foundry, plus a highly trained organization—these are now available to you for the better products of a peacetime world.

The way to buy improved steel castings is to buy them from Dodge Steel.

When may we talk it over with you?

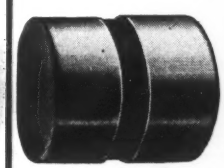
DODGE STEEL CASTINGS

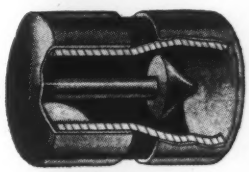
DODGE STEEL COMPANY • TACONY, PHILADELPHIA 35, PA.

First in Circuit Protection

LITTELFUSE MERCURY SWITCHES

With the return of civilian products, Littelfuse Mercury Switches, as before the war, will prove more reliable and adaptable to a wider range of uses. Switching operations are performed by rotary motion—regardless of position of axis in rotation—as applied to rear trunk doors, glove compartment doors, pilots' cock pit doors, hatch doors, or turn and bank indicators, etc.





Actual size of mercury switch 3/8" dia. by 1/16". Note the no-splash feature built into center contact button.

Designed for low voltage circuits and low power applications—the improved Littelfuse MERCURY SWITCHES incorporate invaluable experience gained in war production to bring you better quality at no additional cost.

LITTELFUSE INCORPORATED

4757 N. Ravenswood Ave. • Chicago 40, Illinois

QUALITY IS A CHALLENGE

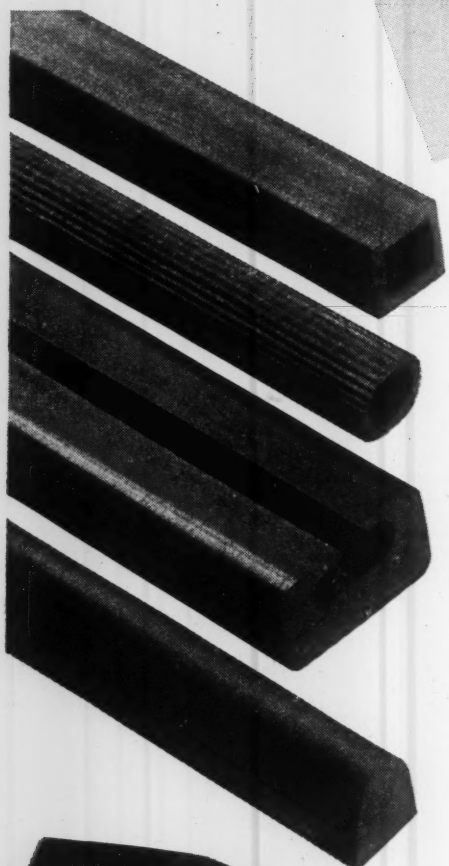
Quality is a challenge which the weak must decline but which the strong joyfully accept. The acceptance demands courageous planning and resourceful thinking. It demands patient research and unending vigilance against the temptation of profitable inferiority; it demands an unbending desire to serve well and the will to pursue unwaveringly the desired standards of perfection.

The path of quality is the road to victorious accomplishment.

President

LITTELFUSE *Incorporated*

PRECISION TO A FINE TOLERANCE!



ACADIA *Synthetic*

SHEETS • EXTRUSIONS • MOLDE

Cut, molded or extruded—Acadia Synthetic Products c be processed to the closest tolerance to meet your m exacting requirements—in any shape, size or type of sy thetic rubber you need.

Chemically, too, they can be compounded to mat specific conditions with emphasis in varying degrees resistance to air, light, petroleum, ozone, etc...or qualiti found in natural rubber—and some that are not.

Tell us the characteristics, or combination of characte istics, you need. Acadia's engineers are ready to help y work out the exact synthetic necessary.

WRITE US TODAY!

ACADIA *Synthetic* **PRODUCTS**

DIVISION OF WESTERN FELT WORKS

Processors of Synthetic Rubber and Plastics • Sheets Extrusions • Molded Parts

DIVISION WESTERN FELT WORKS

LARGEST INDEPENDENT MANUFACTURERS AND CUTTERS OF FE

WITHOUT THIS VITAL *Spring*

The Simmonds-Hobson Automatic Engine Control is made in America by Simmonds Aeroccessories, Inc.

The Automatic Engine Control, that gave America the world's fightingest planes, might never have been completed.

UTOMATIC ENGINE CONTROL is an amazing mechanism. Acting as a hand for the pilot it relieves him the constant manual manipulation essary to keep manifold pressure and ture set correctly as he changes speed altitude. By automatically maining a pre-selected setting throughout b and descent, it assures full rated er output, prevents "over-boost" and ned out engines.

reviously, the constant manual ading of engine controls demanded a t proportion of the pilot's time dur vital altitude changes in combat t. Even so, he could make only intertent and approximate adjustments. attention was constantly diverted his job of fighting. His vulnerato surprise attack was high.

xperts claim that if automatic engine controls had been generally available for Allied fighter planes during the Air-battle of Germany, fighting efficiency would have been so increased that bomber losses might have been reduced as much as 50%.

British fighters that were so equipped made such a remarkable showing that engine control became a hot "must" for our Army.

Production schedules were set up even before design problems were licked. Planes and engines were built. An improved control unit was developed—but when it came to the coil spring that actuates and balances its operation, nobody could be found to make it.

This spring, a vital part of the control mechanism, was required to exert, over every point of its functional range, an exact and unvarying pre-set inch-pound loading. In addition, it had to fit already predetermined and very close space limits.

Our well known spring engineering ingenuity was called upon to overcome this intricate spring problem. Today, we are the main source of supply for this important spring program.

It is this faculty for doing the seemingly impossible—for combining with the fine art of spring design, unusual technical and manufacturing facilities—that we put at your disposal for the solving of your spring problems, no matter how exacting.

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

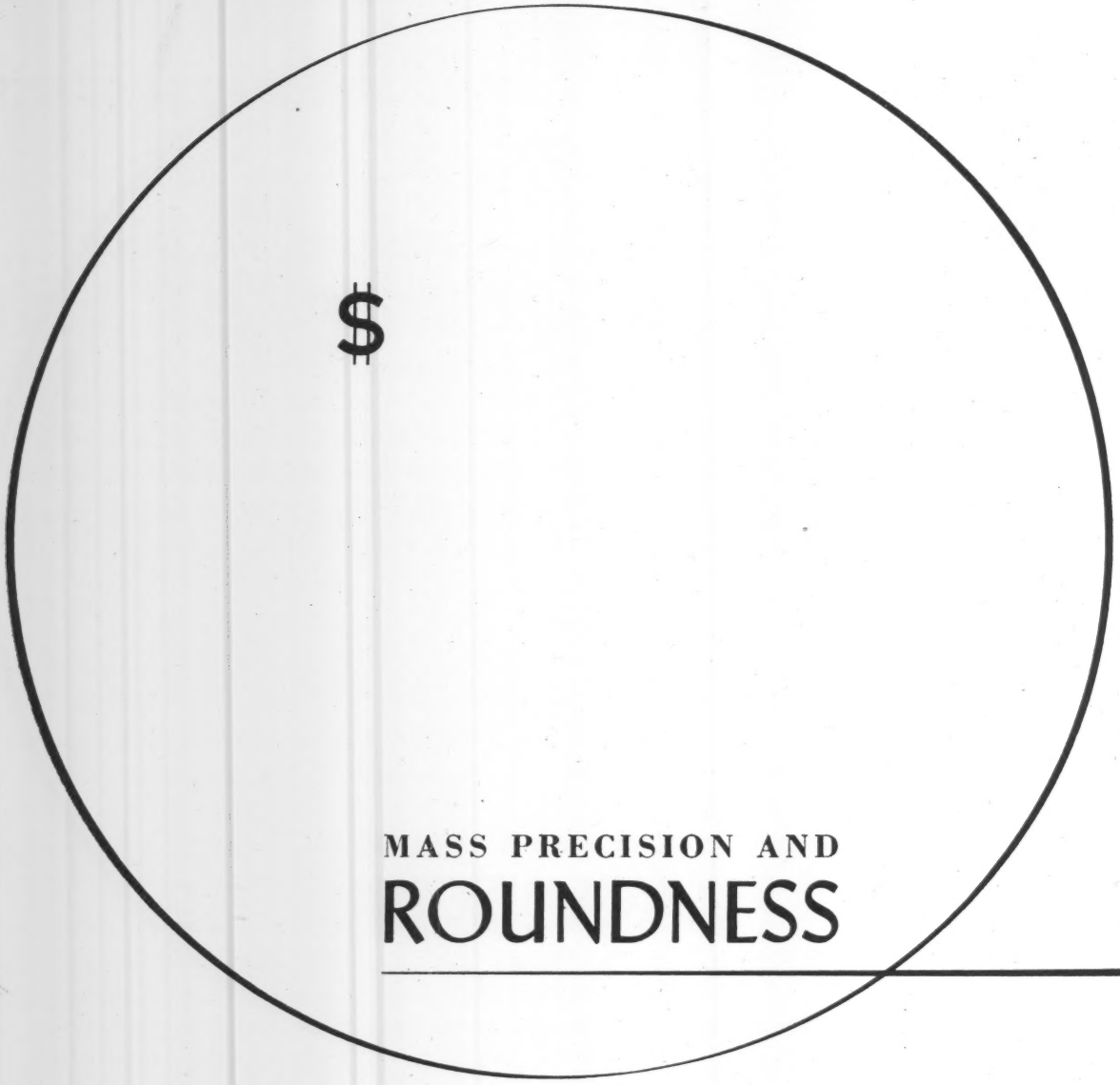
Columbia Steel Company, San Francisco, *Pacific Coast Distributors*

United States Steel Export Company, New York

UNITED STATES STEEL

AMERICAN STEEL & WIRE COMPANY — USS STEEL — UNITED STATES STEEL

U·S·S American Quality Springs



MASS PRECISION AND
ROUNDNESS

Price and accuracy have always been closely united. The finer the work the higher the price. A new production method will change the relationship and lower the price. Years ago it was impossible to get true roundness in production. Today, with advanced methods, round pins .4060" in diameter, and true to quarter-tenth tolerances, are an inexpensive part of a Nichols Assembly.

Perhaps you have an expensive precision manufacturing and assembly job that is a stickler — Nichols would like the opportunity to show you how inexpensively it can be made when Mass Precision methods are applied. Our booklet "Mass Precision" showing some products made for other concerns will be sent on your request.

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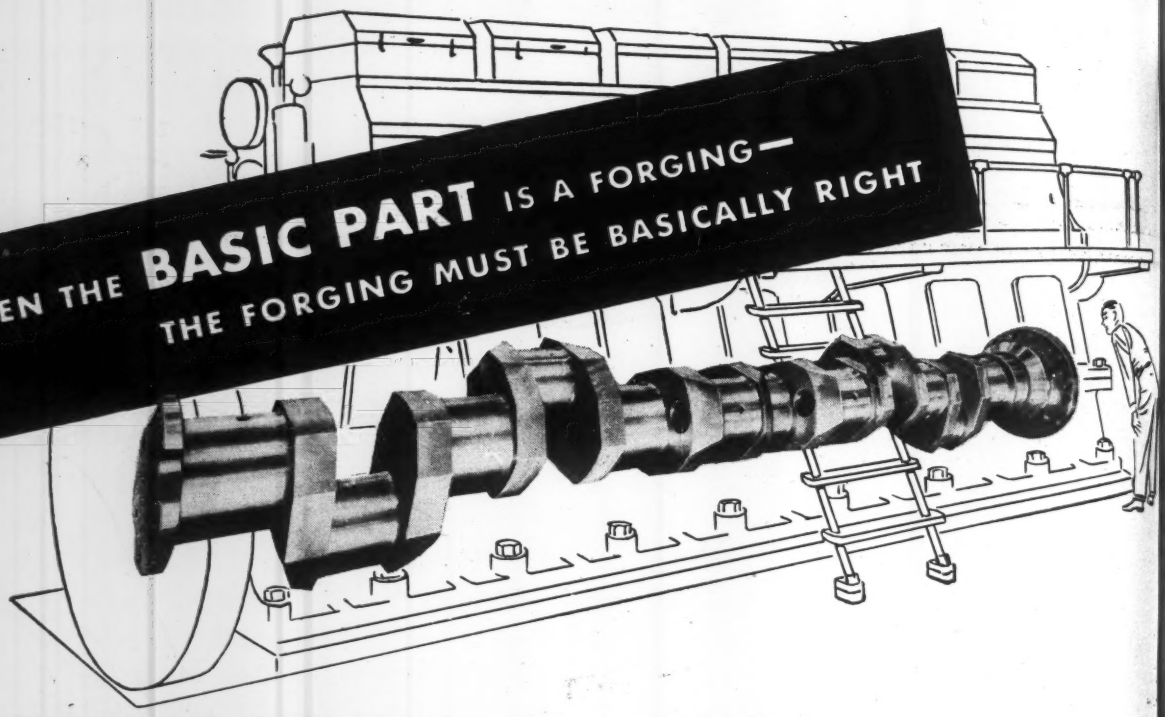

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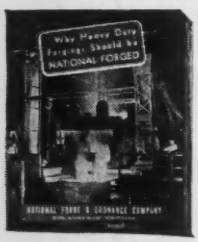

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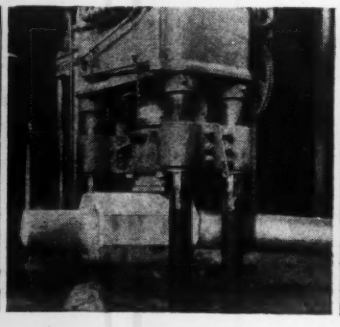

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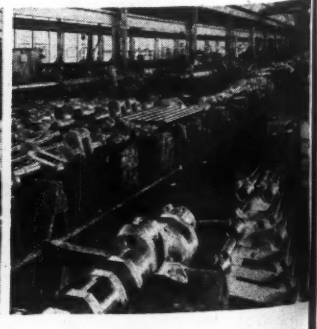

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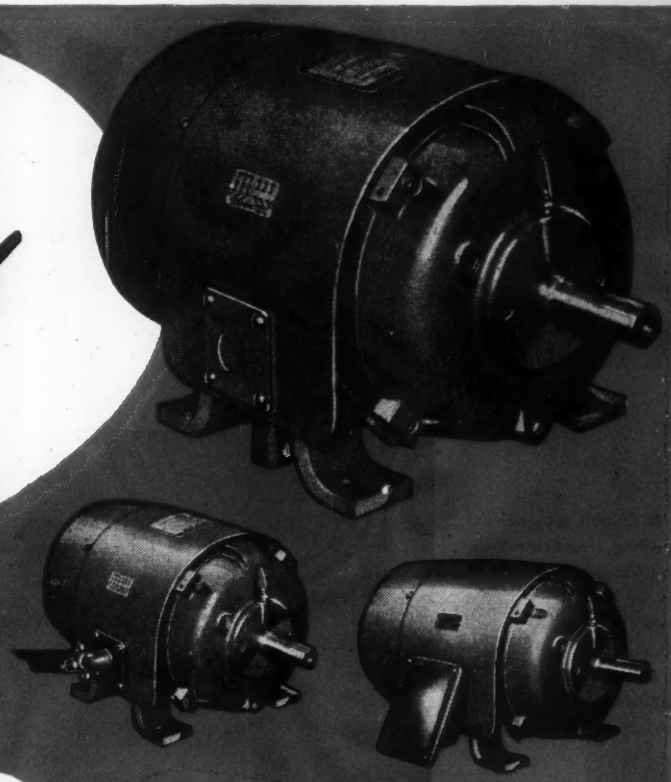

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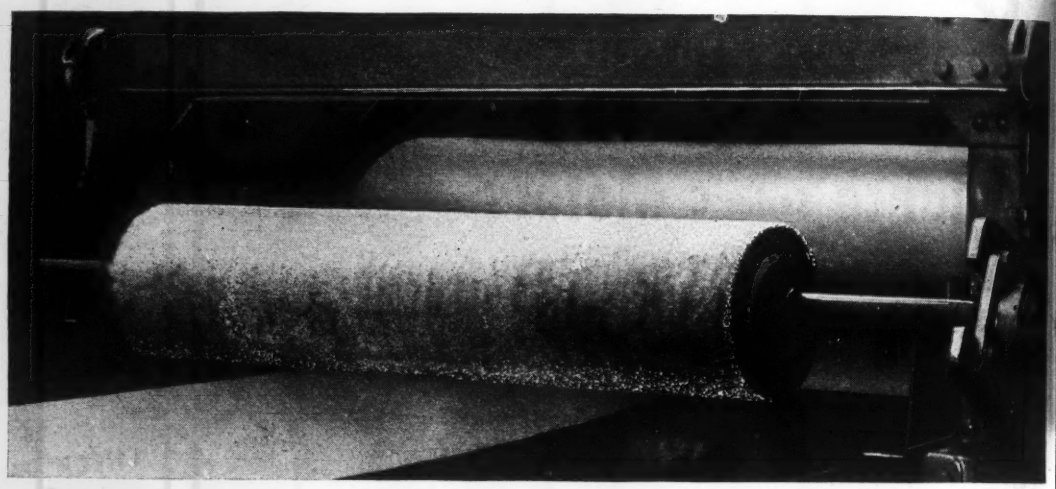

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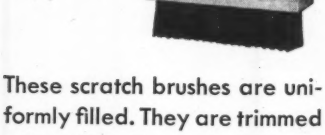

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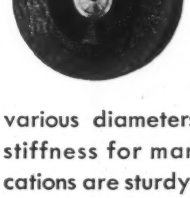

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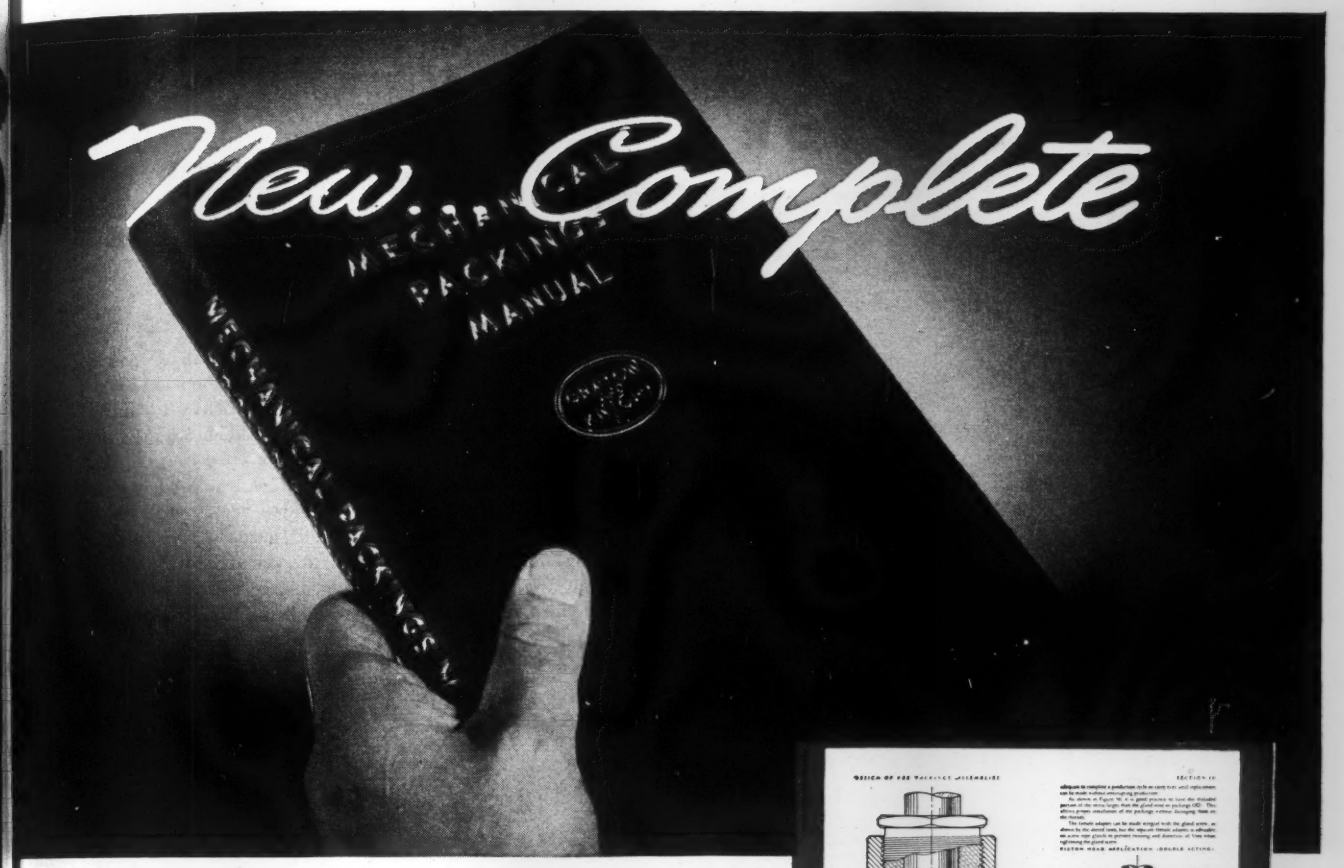

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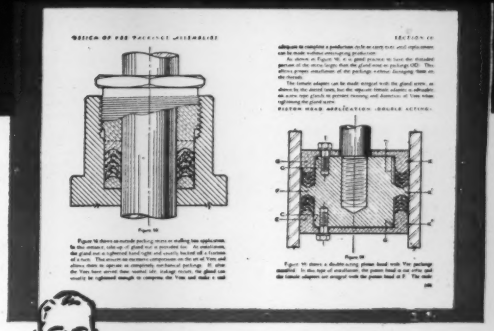

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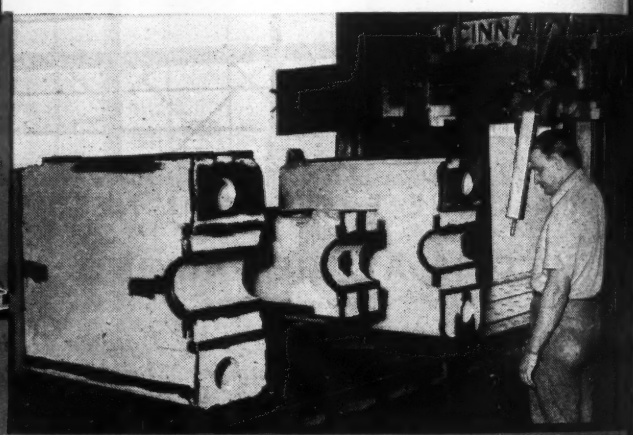
Finishing a precision-tested Bliss press crown, fabricated from welded steel plates at Warren City



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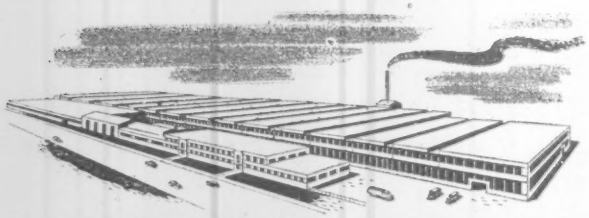

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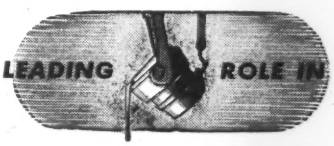
ArmaSteel, cast close to finished dimensions, cuts machining requirements and machining man-hours as much as 50 per cent . . . substitutes profitable production for "chip" production. And besides speeding operations and reducing costs, ArmaSteel offers a uniform structure of great strength and high resistance to shock and stress. Its maximum endurance, high rigidity, excellent machining qualities and long life make it ideal for critically stressed parts.

Engineers and designers are invited to compare the qualities of ArmaSteel with the qualities they seek in the vital parts of their own products.



See How ArmaSteel Speeds Production of Vital Parts

TRANSMISSION PARTS

Comparative figures indicate part of the saving effected by ArmaSteel: Weight of forging formerly used, 8-2/10 lb.; weight of ArmaSteel rough casting, 5-7/10 lb.; weight of finished part, 3-3/10 lb.

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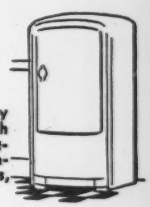

ArmaSteel is used for many parts requiring high strength and wear-resistance—refrigerator compressor unit connecting rods and crankshafts, for instance.

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Topics

SURFACE-FINISH analyzer has been developed by the British which makes use of the interference of fringes of light for producing a series of bands which follow exactly minute differences in the surface under test, these bands being in effect a number of highly magnified pictures of the surface contours. Mechanical errors or electrical effects are eliminated.

REVERSIBLE PROPELLER braking on large, high-performance land-planes will provide greater safety, greater efficiency and greater passenger comfort as well as impressive saving in operating cost. This method of braking has been tested with various combinations of small wheel brakes on a total of 70 landings of a B-32 four-engine bomber, according to Curtiss-Wright Corp. Beside reducing landing runs to one-half, performance is improved through the weight reduction achieved.

DIRECT MEASUREMENT from zero to four inches (reading by estimation to 0.00001-inch) is achieved in a vertical micro-optic measuring machine recently produced in Britain. Fast in operation, its accuracy depends not on moving parts but on a precision glass scale.

LIQUID HONING has been applied to the finishing of aircraft propellers, intricate shell parts, jet engine parts and other parts requiring supersmooth finishes. The process, developed by Vapor Blast Manufacturing Co., is based upon the use of a very fine abrasive in a chemical emulsion which is discharged by compressed air against the surface to be finished in a fashion analogous to sand blasting.

FOG DISPERSAL on airfields is now facilitated by the development of a new type burner using diesel fuel oil instead of low octane gasoline. Developed by Babcock & Wilcox Co., the burners are ignited electrically from the control tower, burning with a bushy flame of an intense heat and minimum smoke while in operation, starting up or shutting down. Fuel oil is forced through the nozzles at pressures between 1000 and 15,000 psi. Since no preheating or vaporizing is necessary the flame can be ignited when the valve is opened.

HERMETICALLY SEALED in welded cans, aircraft engines are protected against moisture and damage in their shipment to occupation areas. Secured to shock mounts in the bottom of the container, the engines are under 8 psi air pressure, pumped through a valve which can be checked for leakage with an ordinary tire gage.

BUG BOMB aerosol dispensers, used by the armed services to combat malaria and yellow fever in insect-infested areas will be available to civilians in the near future. Combining DDT with quick-acting pyrethrum insecticide the bomb differs from other insecticide dispensers in that it releases a fine mist into the air, the pressure being supplied by freon.

ELECTRON MICROSCOPE, because of its ability to recognize particles as small as 0.005-micron, is being utilized by Westinghouse in the study of air-cleaning problems. Not only can the nature of foreign material in the air be studied but also the efficiency of the air-cleaning process itself can be evaluated.

BOLT, NUT, SCREW and other fastening devices produced by 500 companies averaged $500,000,000 in shipments annually during the war years, screw machine products produced by 1200 companies averaged $800,000,000 annually, and pressed metal parts produced by 2800 companies averaged $1,500,000,000 annually, according to WPB.

COAL PLANER, a radically new type of coal mining machine developed by the Nazis, eliminates the costly task of cutting, drilling, blasting and loading. Taking a 12-inch slice from the lower third of a coal seam the planer loads onto a chain conveyor as it is pulled along by wire cables. The upper two-thirds of the seam caves over the planer and into the automatic loading troughs. In this way the machine can mine 800 tons daily from a single working place.

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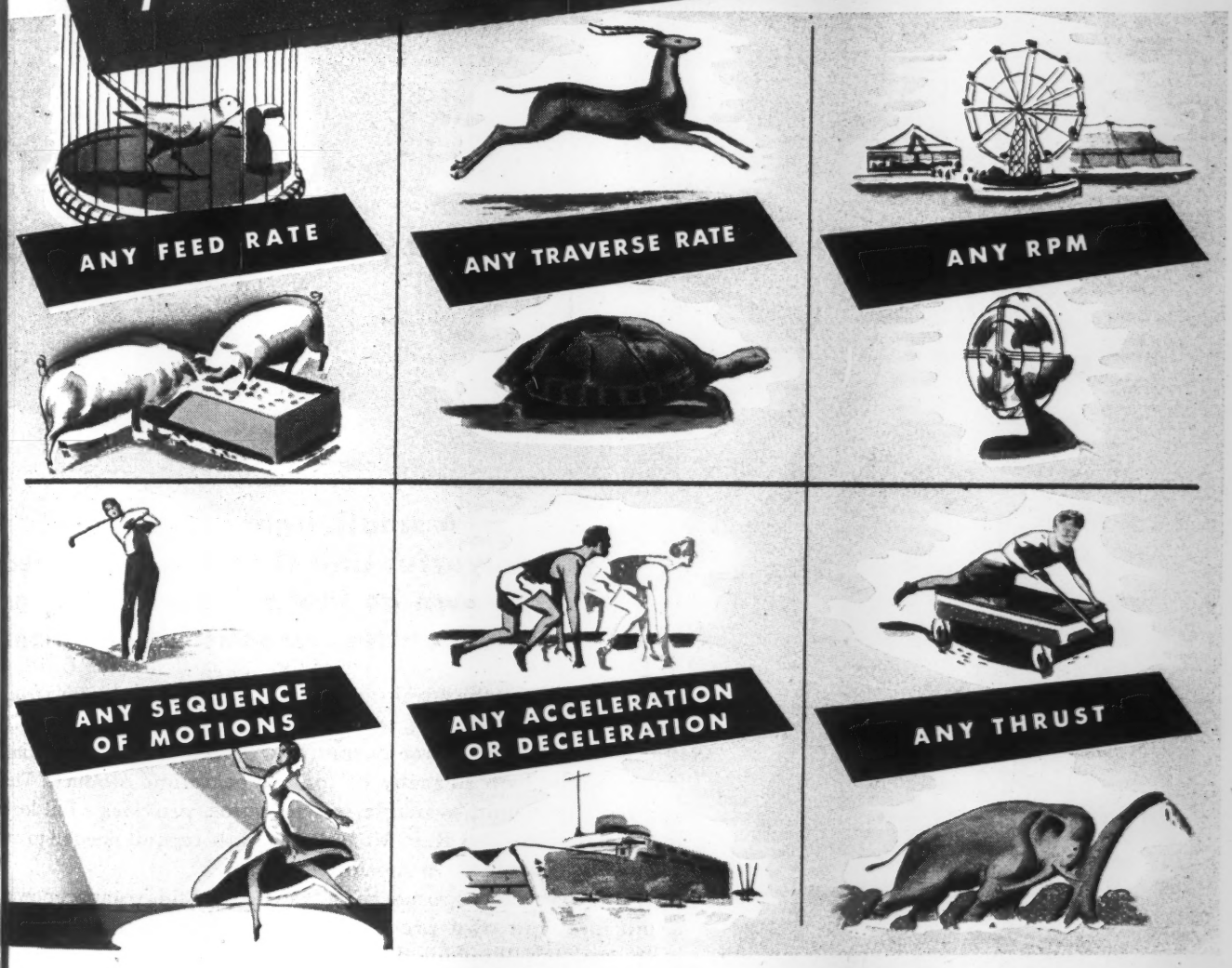

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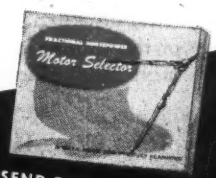

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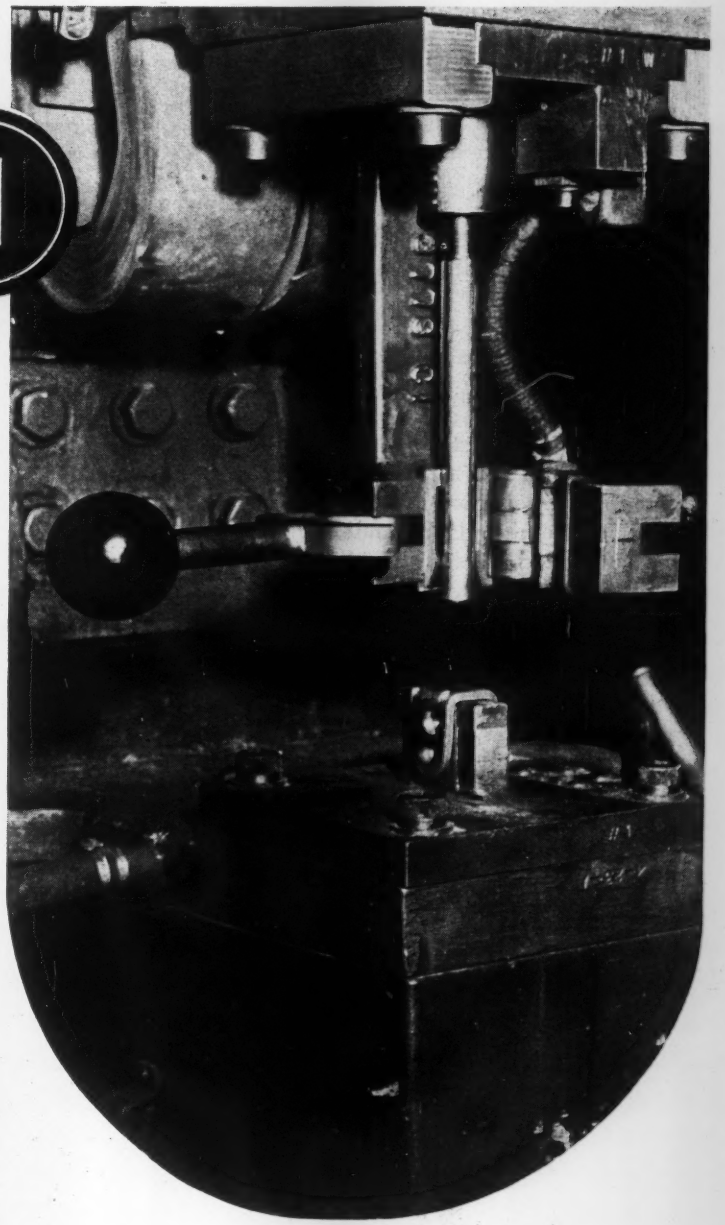


Projection Welding for Short Runs

By R. O. Klenze
Design Engineer
Acme Steel Co., Chicago

ORDINARILY considered economical only for large quantity production, resistance welding is now being employed for short run work with equally satisfactory results. Use of inexpensive fixtures on press type resistance welders, in a manner comparable to a punch press with various die sets, makes possible improved design, increased production and lower costs. A wide variety of cast and forged parts can be redesigned for resistance welding. Cost comparisons on some jobs have shown substantial savings on quantities as low as a thousand parts.

No intermediate material is used in resistance welding. The heat for welding the

Fig. 1—Parts to be projection welded in welding machine. Fixture is open to show contact

parts is produced by their resistance to an electric current. When the current and heating are localized through a small area by electrodes of proper shape the well known spot weld is produced, a most satisfactory method of joining light sections. Another way of localizing the current and heating is by means of projections formed on the parts. This method, known as projection welding, is of special value in joining heavy sections by utilizing welding machines of moderate capacity and by employing suitable fixtures, *Fig.* 1.

Low-carbon steel requires the least critical welding conditions. Satisfactory welds may be obtained over a wide range of current, pressure and current timing combinations. The following examples and discussion apply to parts made from low-carbon steel.

The handle, *Fig.* 2, is an excellent example of a part suitable for redesign as a welded unit. *Fig.* 3 shows the redesigned, resistance-welded handle which is now replacing the former cast handle. The handle now consists of a length of cold-drawn steel tubing, resistance welded to a yoke which was made on a punch press. The yoke is blanked from cold-finished steel in a compound die. Two upper pin holes which are too close to the bend line to remain circular after forming are omitted in this blanking operation. After forming the yoke they are drilled in a simple universal drill jig.

Fixtures to position parts for resistance welding are simple to design and inexpensive to build. They are made from a nonmagnetic material having high conductivity and sufficient strength for the pressure used in making the weld. Contact surfaces are generally a hard copper alloy so designed that they may be replaced easily. Water cooling of the contact surfaces is preferable and should be provided wherever possible. Air cooling, however, satisfactory in some cases when a small amount of heat generated and ample time for its dissipation is allowe between welds.

A resistance welding fixture installed in a welding ma chine is shown in *Fig.* 1 with the parts to be welded in place. This fixture, used in welding the handle shown in *Fig.* 3, made 3000 welds before redressing of the contacts became necessary.

Hinged portion of the upper fixture as seen in *Fig.* was left open to show the upper welding contact. Bo upper and lower contacts are Mallory No. 3, a fairly har copper alloy with good conductivity, and are attached t the aluminum-bronze castings with screws. All contac surfaces between inserts, castings, welder platen and wor are ground to insure good conductivity. A flexible cop per braid to the right of the handle carries current fro the upper platen to that half of the welding contact in th hinged portion of the tube clamp. Current thus enter the tube from the sides about ¼-inch above the weld rather than from the upper end of the tube.

Air Cooling Is Employed

Water cooling is not practical in this fixture because the upper part has a hinged welding contact. Air cooling therefore, was decided upon and has proved satisfactory A portable blower of the type used to clean motors is em ployed, the nozzle being directed toward, and located about 10 inches from, the welding contacts.

While redesigning the handle for resistance welding various radii and bevels were tried on the tube before ob-

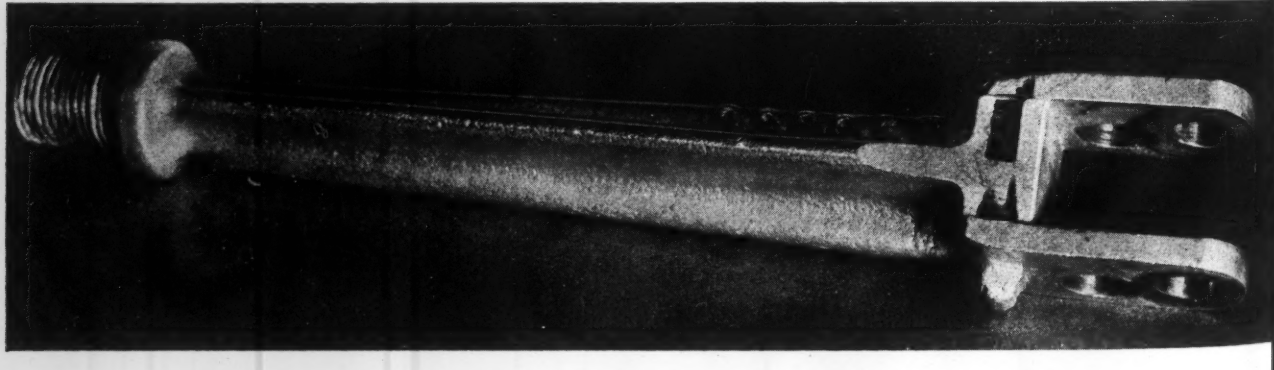


Fig. 2—Above—Original handle for a strapping machine was a casting

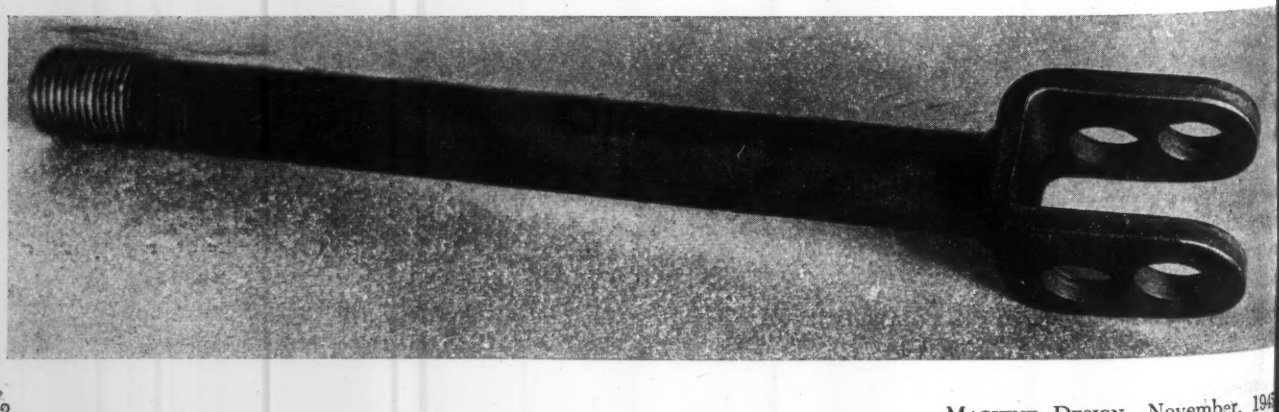


Fig. 3—Below—Redesigned handle is tubing projection welded to a stamped yoke

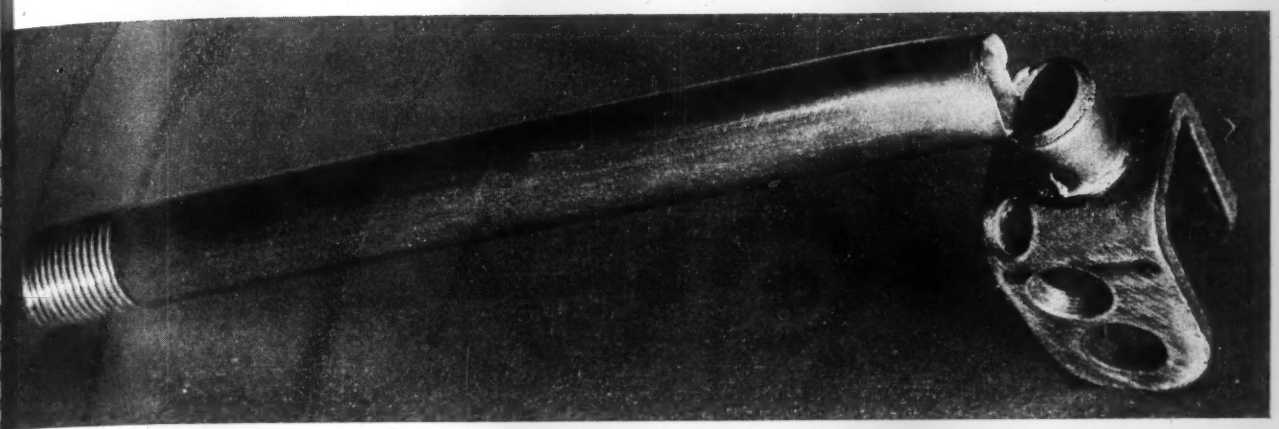


Fig. 4—Above—Typical failure in a destructive test of resistance-welded handle. No specimens tested failed in the projection-welded joint

aining a satisfactory weld without flash. The final projection dopted is a simple bevel made on he screw machine at the time the ubes are cut to length. Flash is educed sufficiently to eliminate he need for its removal. Failure n a destructive test, *Fig.* 4, always ccurs in the tube and not in the eld.

Base Is Combination Welded

Another good example of a part uitable for redesign is the base or a strapping tool shown in *Fig.* 5. This base was originally a heat-reated alloy-steel casting. All the parts of the redesigned base, *Fig.* 6, are cold-finished steel to facilitate welding. After welding and machining, the completed base is eat treated to obtain the required trength. *Fig.* 7 is an exploded iew showing the seven parts hich are welded together to make he base.

Immediate Production Desired

Owing to delay in obtaining teel castings, it was necessary to ut the welded base into production. Fixtures had been built and esistance welding procedures set p for only three of the welds. Arc elding of the other parts, however, permitted immediate production of the base. A careful cost nalysis will be made when time is vailable. If this indicates a further reduction in cost can be obained by resistance welding the arts now being arc welded, these arts too can be redesigned. The resent combination of resistance nd arc welding may prove to be

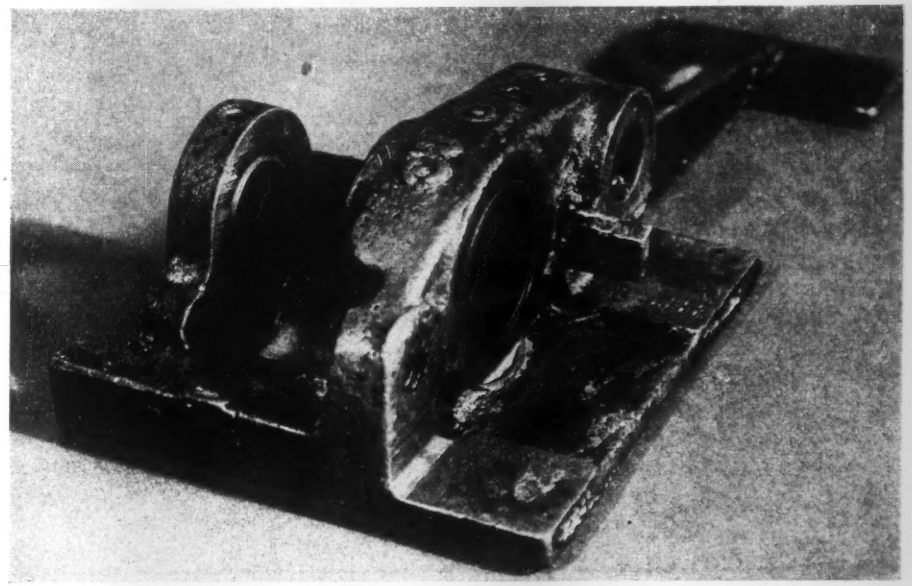
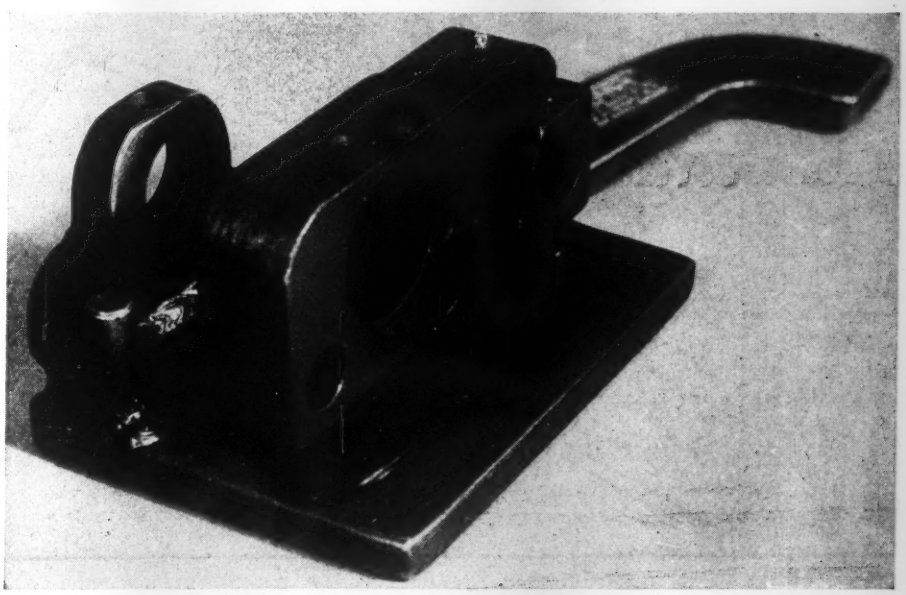


Fig. 5—Above—Original cast steel base for a strapping machine

Fig. 6—Below—Welded base replaces base in Fig. 5. This base is a combination resistance and arc welded assembly



the most economical way to make this base.

Welding of the large block *A*, *Fig.* 7, to the flame-cut base plate *B* is the most interesting problem on the redesigned base shown in *Fig.* 6. The two projections on the bottom of this block, *Fig.* 8, required for projection welding to the plate are obtained by form milling the block in two directions. It would of course be more economical to form hemispherical projections in base *B* with a punch press and experimental welds of this type were made. Tests showed, however, that projections of sufficient size to make good welds weakened the base and produced an unsatisfactory product.

Pulsation Welding Employed

Pulsation welding is used, the timer setting being: Weld interval 360 cycles, heat time 10 cycles and cool time 4 cycles, using a 60-cycle control current. This setting of the timer applies pressure to the weld for 6 seconds but the weld current does not flow continuously. It flows in pulses of 10 cycles with an off time of 4 cycles between pulses.

The welding fixture for this base is copper and both the upper and lower parts are water cooled. Upper welding contact is Mallory No. 3, and the lower welding contacts consist of two rectangular pieces of Elkonite 10W53, silver soldered to the lower part of the fixture. These pieces contact the lower surface of the base plate *B* as shown in *Fig.* 9, directly below the projections on block *A* when the parts are positioned in the fixture. The upper welding contact is held in place with screws and required dressing after approximately 1000 welds. The lower contacts have made 8000 welds without dressing.

After these jobs were rated and the fixtures turned over to the shop for production, excessive wear of the welding contacts was reported. Investigation showed that the operator, after acquiring a little skill, could and did ma welds in less time than that at which the job was rat This produced heat in the fixture at a rate greater th that which the cooling provisions could dissipate, caus the contacts to burn and requiring frequent dressi When the fixture overheated the operator would take ti off until the fixture cooled, but the damage already ha occurred. This is a common problem in shops where pie rates are established on all jobs. The solution of this w simple and has proved satisfactory in production.

As the production rate for which the fixture was d signed was satisfactory and refrigeration methods of coo ing were too expensive for short run welding, an ine pensive, adjustable mechanical timer was installed in th control circuit. This device made the welder inoperativ for a predetermined time after a weld was completed. Th welding machine still remained under the control of th operator as the timer did not control the maximum tim intervals between welds. The next weld was not ma until the work was located and the operator closed th usual switch for initiating a weld. If he closed the switc too soon, nothing happened. The operator need on keep his foot on the switch and after the proper interv of time the machine would commence the welding cyc

Welds Can Be Duplicated

The press type resistance welder used for the produc tion of these parts consists of a heavy frame to which i attached a fixed lower electrode and a movable upp electrode. Pressure is applied to the upper electrode b means of an air ram. A transformer located in the fram of the welder provides the low-voltage, high-amperag welding current required. An electron-tube timer an power switch control the welding cycle.

Projection welding makes possible the use of a moderat

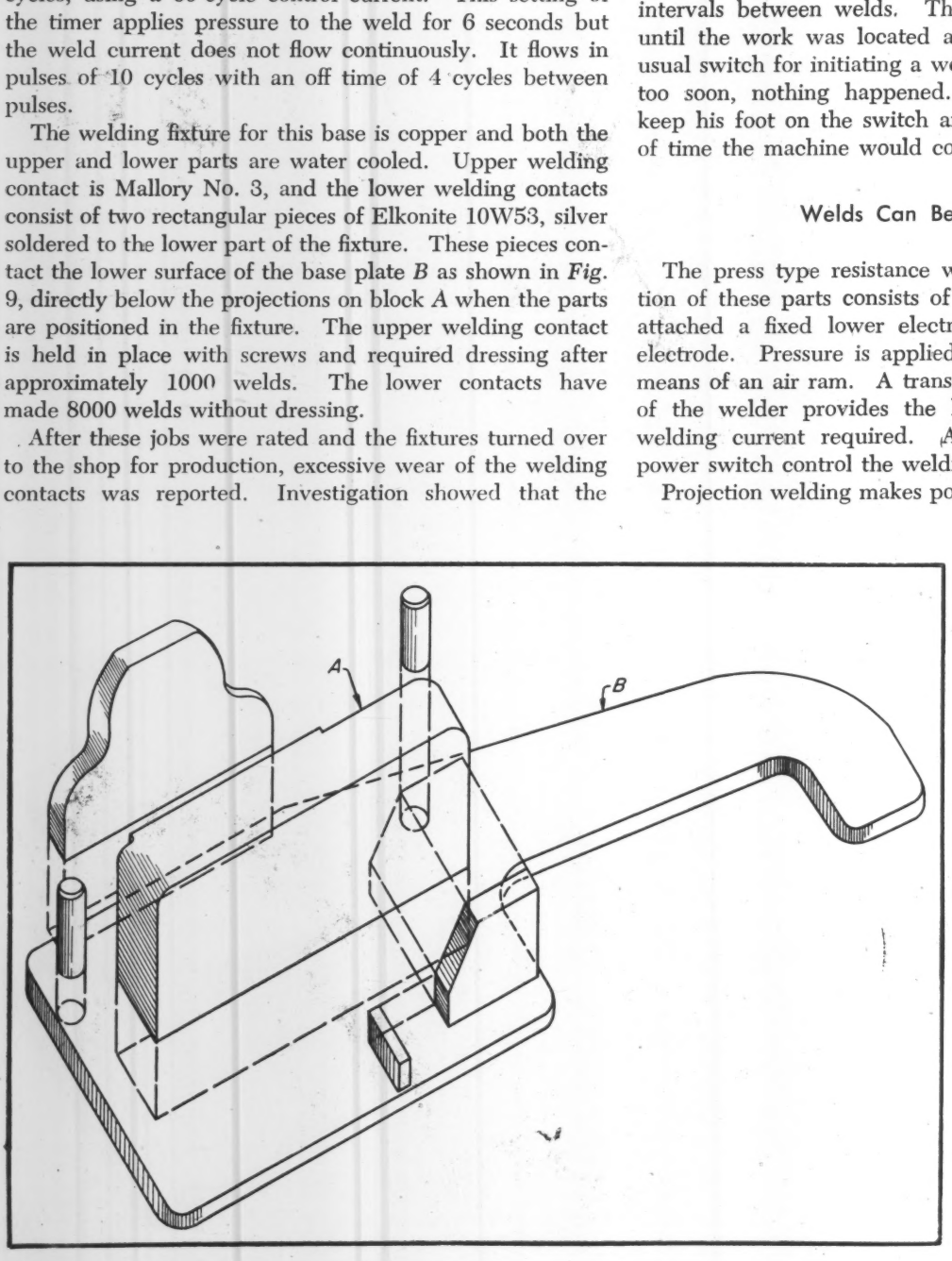


Fig. 7—Drawing show ing seven parts use to make the base i Fig. 6

ize welder but requires a careful design of the part and he establishment of an exact welding procedure. Once welding procedure has been established it requires but ttle time to set the welder controls and install a fixture to uplicate a previously made weld.

Cleanliness Is All Important

Cleaning of the parts to be welded is of the utmost im-ortance. The soil on low-carbon steel consists principally f mill scale, rust, oil, dirt and grit. Resistance is an im-ortant factor in making a weld. If varying amounts and inds of soil are present, uniform welds cannot be made ecause of variations in resistance. The surfaces contact-ng the electrodes must be as clean as the surfaces to be welded. If soil prevents the electrodes from making good ontact they start to burn in spots. This continues until he entire surface is destroyed. All soil must be removed o produce uniform welds of maximum strength and also o obtain satisfactory life of the welding contacts. On mall parts the use of cold-rolled steel eliminates the scale nd rust problem, improves appearances and generally is more economical than any satisfactory method of scale re-moval. Most pickling methods for scale removal leave a film caused by the pickling acid or the inhibitor that is as objectionable in welding as the mill scale. A satisfactory bright pickle or a grinding operation requires immediate welding before parts begin to rust, or intermediate oiling.

Blasting with chilled iron grit is a satisfactory method of scale removal in some cases. Sand blasting must not be used, as the sand driven into the surface is almost as ob-jectionable in welding as the scale it removes.

Washing in a vapor degreaser with an organic solvent immediately before welding is the most satisfactory method of removing oil and dirt. The small amount of grit which still remains on the parts does not affect the weld appre-ciably, but does cause pitting of the welding contacts. In many cases the number of welds made between dressing of contacts can be tripled by wiping this grit from the part when loading into the fixture.

Washing in a detergent followed by a hot water rinse is not satisfactory. A film of calcium and magnesium salts from the hot water rinse tends to form over the parts. This film is responsible for the lusterless or streaked appearance of the metal and interferes with the welding operation even though the preceding washing operation has removed all oil and other soil.

Welding fixtures must be kept clean to produce uniform welds and obtain the maximum contact life. New or re-dressed contacts should be lightly coated with grease be-fore making the first weld. The fixture and contacts must then be kept free of oil, dirt and splatter from the welding.

After contacts are fitted and burned they should be ground or machined to the original dimensions by the tool room. A file used by the operator is not a satisfactory way to dress contacts; it is preferable to provide him with suf-ficient replacement contacts for the job.

A fundamental requirement for good welding, often overlooked, is heat balance. Heat balance exists when the fusion zones of the pieces to be joined undergo ap-proximately the same amount of heating. This balance exists when the parts are of equal thickness and of the same material. When the parts are of different thick-

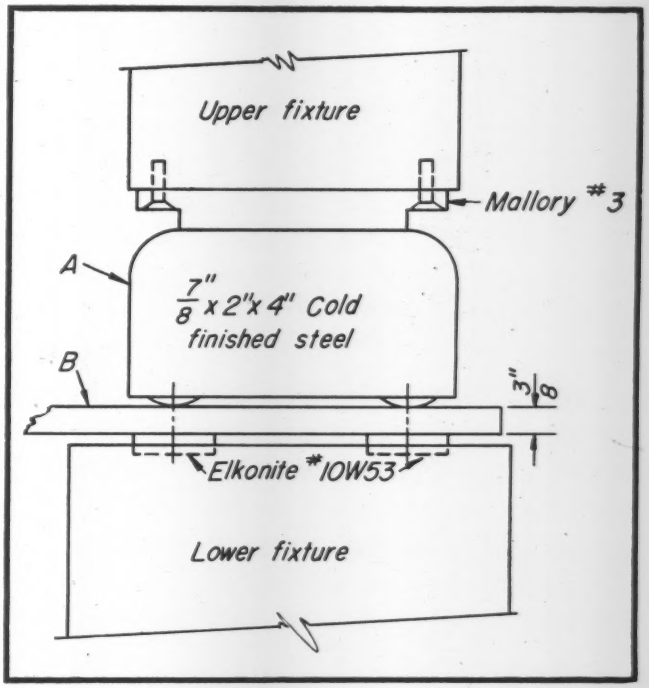


Fig. 9—Above—Base in welding fixture showing position of welding contacts with respect to projections on block A

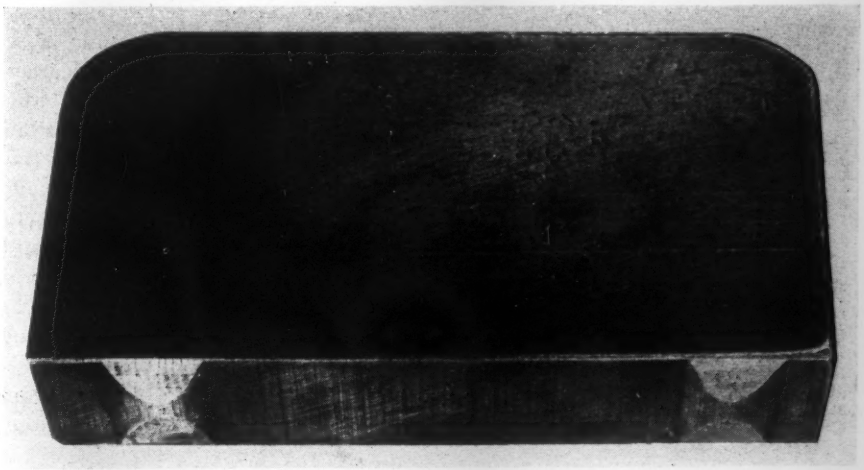


Fig. 8—Right—Projections on base block A are made by form milling in two directions

nesses or materials the heat balance, though the effect is difficult to evaluate, is obtained in several ways. In spot welding it is obtained by using electrodes of different sizes and materials. In projection welding, area, proportions and locations of projections in conjunction with the choice of electrodes controls the heat balance.

Ideal Projection is Dome Shaped

Design of projections for materials up to 3/16-inch thickness are well established and tables in several of the references listed at the end of this article give their proportions. The current required is approximately the same as for a spot welding material of equal thickness. On heavier material extrapolation of these proportions is not always satisfactory. Experimental welds of various proportions must be made on the welding machine. The preferred projection is dome shaped and made on the thickest piece. If multiple projections are used all must have the same height. They must withstand the initial pressure without undue deformation and have sufficient mass to raise a spot in the other piece to welding temperature. The projection should collapse during welding, without splatter between the parts and the parts should come together. The proportions of a projection on low-carbon steel may be varied over a considerable range with satisfactory results, but as the area is increased the current is proportionally increased and it becomes difficult to obtain uniform current distribution throughout the weld area. Current required on heavy pieces with correctly designed projections is much less than that required for spot welds on equivalent thicknesses of material.

Designers should remember, though this article deals primarily with resistance welding, redesign of certain pa for arc welding or for a combination of arc and resista welding may be most economical. It is also well to be in mind that the strength of a resistance weld need on be the optimum required for the part. Stress calculatio of a part, particularly one made of several pieces, oft indicate a perfect weld is not required in certain place Use of such data permits him to simplify design and wel ing procedure. In a highly stressed part the grain grow occurring in a weld may be refined by subsequent he treatment. Some of the more complex welding machine now available permit the weld to be heat treated whi the part is in the machine. This is accomplished by a se ond heating cycle, having different values of current an pressure, applied immediately after the welding cycle.

Resistance welding methods, when used for long pr duction runs on specially designed equipment, are we established. Short production runs making use of ine pensive fixtures are not so well understood. Experience however, has enabled designers to make practical an rather common the design of parts to be made on a punc press and die sets for production runs as small as a fe thousand pieces. Once they become equally familiar wi the design of parts for resistance welding and the desig of welding fixtures, they will find the resistance welder versatile machine for short production runs.

References

Resistance Welding Manual—Resistance Welder Manufacturing Associa tion.

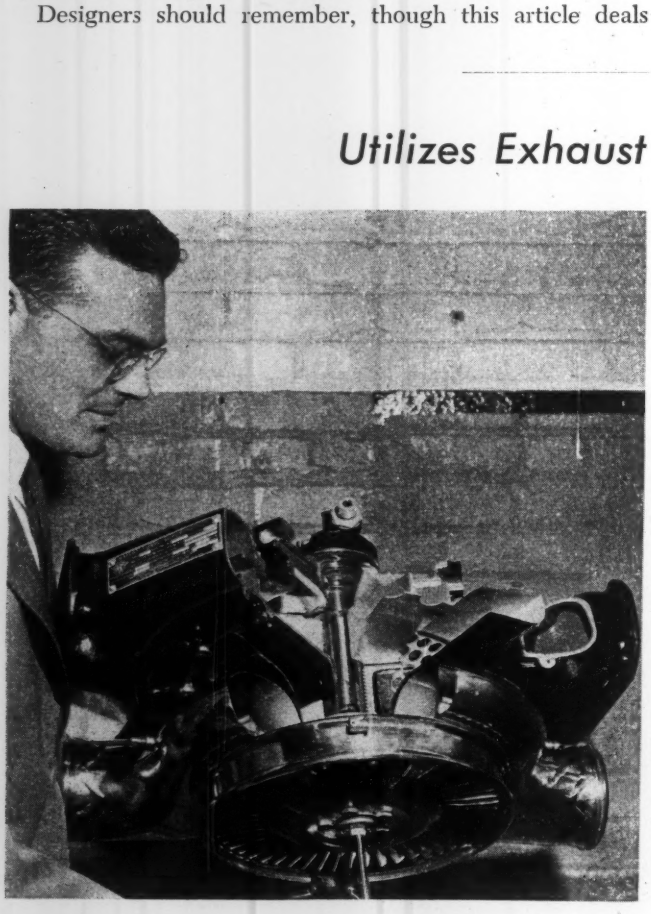
Resistance Welding Equipment Standards—Resistance Welder Manufa turing Association.

Resistance Welding Data Book—P. R. Mallory Co.

Resistance Welding—A Method of Metal Fabrication—General Electr Co.

Electronic Control of Resistance Welding—G. M. Chute.

Utilizes Exhaust Gases for Power



OPERATING from engine exhaust gases, the turbosu percharger illustrated is lighter in weight, more com pact and more adaptable to varying aircraft engine ar rangements than other designs. Within its clam-shape housing, engine exhaust turns the turbine at 25,000 rpm developing 150 horsepower to spin the centrifugal com pressor. Designed by Wright Aeronautical Corp. the turbo installed behind the aircraft engine, feeds air to the engin for increased power or for aiding the engine to "breathe properly at high altitudes.

Capable of withstanding exhaust temperatures as hig as 1700 degrees the turbo has been proposed for use i commercial transports. For this use the unit has excep tional "acoustic filter" properties, increasing the comfort o air transport travelers by muffling the exhaust noise. Th turbo also may be used to pressurize passenger cabins Turbosuperchargers function at maximum efficiency with out relationship to speed nor to altitude.

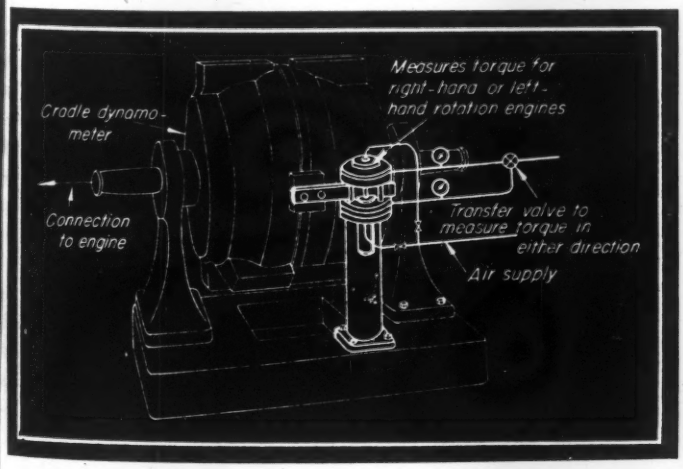
In the experimental work to produce the advanced de sign the Wright company has gained experience and made important discoveries useful in the furtherance of its gas turbine work. Because the turbosupercharger is a "gas turbine in reverse", experience in both fields is largely in terchangeable.

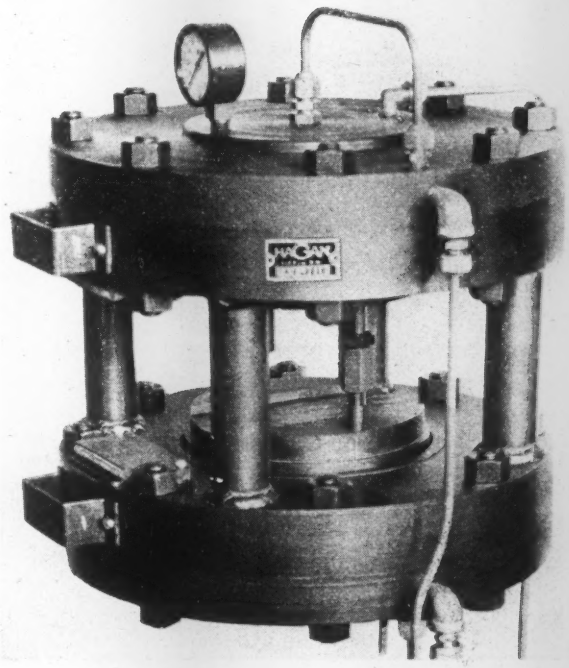
Scanning THE FIELD for Ideas

FLEXIBLE diaphragms in thrust measuring unit shown at right obviate intricate mechanisms, knife edges and other parts subject to wear. Developed by the Hagan Corp., the unit is equally capable of measuring forces as small as a few pounds or as large as the thrust of a jet airplane engine. In the sketch below the instrument is applied to a cradle dynamometer to measure torque in either direction.

Flexible diaphragms form one face in each of the two airtight chambers. Compressed air is admitted to this chamber through a poppet type pilot valve. The force to be measured is applied to the outside of the diaphragm and is opposed by internal pressure. As the force increases, the pilot valve is opened and admits more air to balance the increased force. As the force decreases, air is exhausted until the external force and internal pressure are equal. Thus the air pressure within the chamber provides a direct measure of the externally applied force and may be indicated remotely by any desired number of manometers, pressure gages or recording devices. Response of the instrument is practically instantaneous because the diaphragm movement necessary to operate the pilot valve is extremely small.

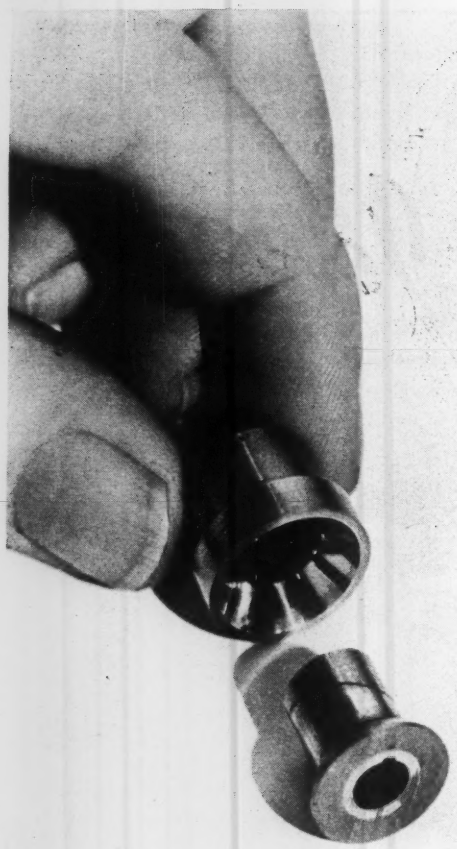
Because of its simplicity, the instrument may be used in any position, facilitating torque measurement





of vertical helicopter engines. Its compactness and ability to provide a reading of force with practically no deflection suggest utilization for analyzing many structural stress and strain problems. Construction of the unit permits its use under conditions where dust and dirt or cramped quarters preclude application of conventional measuring devices.

Cemented-carbide bearings with journals of the same material have been applied to small grinders by the Carboloy Co., minimizing maintenance and increasing bearing life more than fifty times over the bearings previously used. Diamond wheels are used in these grinders, the necessary



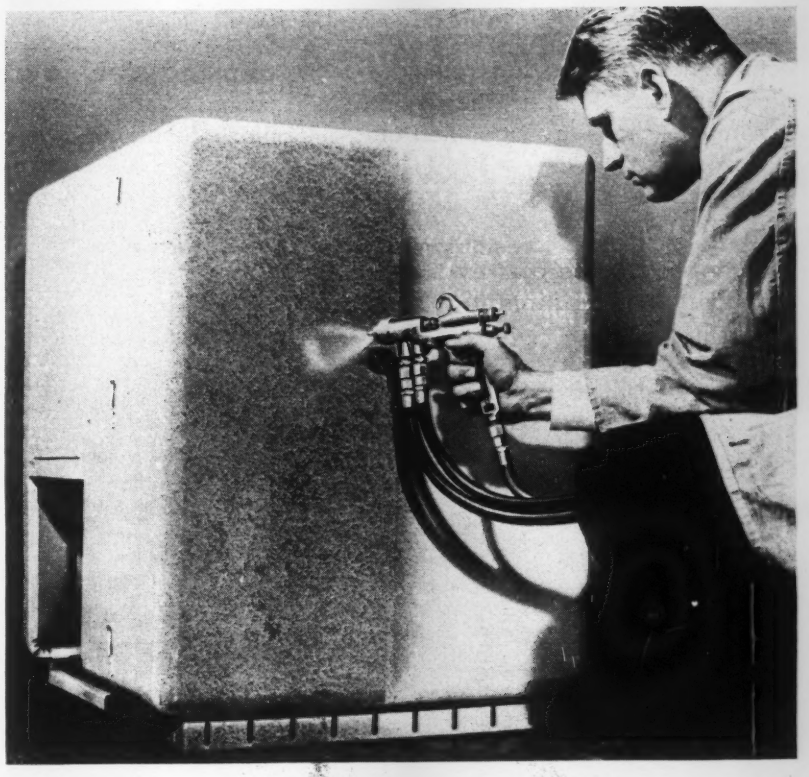
wheel pressure being about ten times that employed with re
ular abrasive wheels. Under these conditions the standa
bearings, designed for normal service, ran accurately for on
a week and then showed signs of wear.

Installed at each end of the grinder shaft the carbide bea
ings, left, are combination thrust and radial-load sleeves wi
conical surfaces. The outer bearing member is 78B Carbol
with a running clearance of 0.0005 to 0.0008-inch. Grade 44
Carboloy is used for the journal and is attached to the sha
with Woodruff keys. The surfaces are grooved for the lubrica
which is a mixture of kerosene and colloidal graphite fed t
the bearing through a cup and wick. Bearing surfaces are di
mond lapped to a finish of one to two microinches.

Chemical compositions of solids, liquids or solutio
may be analyzed in a short time with an infrared spectroscope
shown below, developed by Westinghouse Research Labora
tories. Infrared light, produced by heating a silicon carbid
rod to incandescence, is passed through the specimen to be
tested. Mirrors and prisms guide the light along a 30-foo
zigzag path to sensitive receivers. These receivers conver
the light into electrical current, amplify it and record the in
formation electronically on a chart outside the machine. From
the peaks and dips on the chart it is possible to identify ele

ments quantity of each, amount of impurities, etc. The analysis depends on the characteristic frequencies of the molecular vibrations in each element which the spectroscope can identify by tuning the frequency of the infrared beam. Also, fundamental data on molecular structures may be obtained through the use of this instrument.

Simultaneous spraying of two colors produces the effect of two-coat spatter finishes by utilizing a gun to spray the two colors through one nozzle as illustrated at right. The gun, developed by Sherwin-Williams, differs but slightly from ordinary spray guns. It has the normal control valve and fluid control valve, trigger assembly, head, fluid tip, and needle. However, it has an additional fluid inlet near the head of the gun to accommodate the second color paint. Some of the pattern styles obtainable include: Smooth finish color over color, color over metallic, metallic, and a combination of metallic enamels simulating hammered finish.



Fiber-molding process is being utilized at General Electric's Pittsfield plant to insulate irregular-shaped parts or windings, right. Eliminating the conventional slow taping operation, the process provides a uniform distribution of paper pulp on the part being insulated. The object to be treated is wrapped with untreated tape and a fiber tube attached to the tape. The form is then suspended in wet pulp and the pulp is sucked around the part by connecting the tube to a vacuum pump in such a way that the tape provides a channel for the water to be removed from the pulp. The form is left in the slurry till the desired wall thickness is obtained. Complete drying is obtained by placing the part in an oven. White tape is

wound about the insulation to protect it from impurities during the drying operation. Prior to the drying, any imperfections are smoothed out.

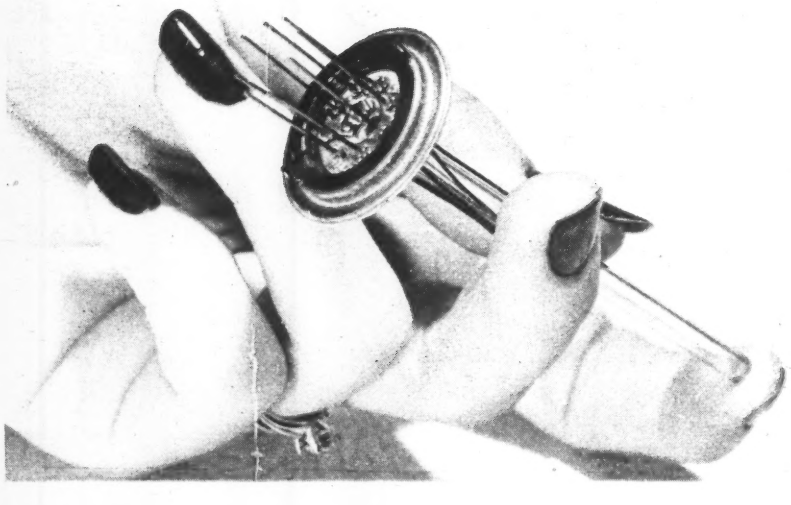
Grid patterns for studying strain analysis have been applied in the past by more or less cumbersome methods. Douglas Aircraft and Carnegie Illinois Steel

have, however, simplified the procedure by spraying a light-sensitive paint called Transfax on the specimen to be tested. A reduced negative of linear coordinate graph paper is then laid in contact with the painted surface and exposed to the light of a flood lamp. Washing the surface with a weak solution of ammonia water leaves the surface with fine white grid lines. After the specimen has been deformed these lines are examined, shown above, with a low-power microscope which includes a reticle with accurately spaced lines to measure distortion.

Fusing steel to glass in a permanent airtight seal is being accomplished by a new process which is more foolproof than other methods and, in addition, permits the use of a staple metal for the seal instead of special alloys which are more costly and sometimes scarce. The new procedure, developed by RCA engineers for sealing metal-enclosed tubes, depends on good "wetting" of steel by glass and on mechanical design which provides compression strains at the glass-metal boundary to compensate for differences in expansion of the two materials.

Surfaces sealed by the new method are the outer edge of a flat, round glass button and the inside of a metal band. As shown below, the glass button serves to insulate the wire leads and the metal band is an insert which is joined to the header by welding. The principle which permits the use of steel for the insert involves the fact that glass is a solvent for oxides. By applying intense heat from fine jets of gas flame to the outside of the oxidized steel band after the glass has been softened and pressed into the band, all excess oxide is dissolved into the glass. Before this principle was applied too much oxidation was as serious an obstacle as too little, the latter preventing adhesion while the former left a porous interface between the metal and the glass.

This advance in the manufacture of metal tubes greatly simplifies production by eliminating individual seals in metal for each wire connection, replacing them with a more dependable seal between the button and header. All the leads in the new design go through the glass button and are sealed to it.



Selecting Materials for the Jeep

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Part II—
Specific Applications

UNLIKE FORGINGS used in some other types of machines, those used in the automotive industry almost always are hardened and tempered. Alloying elements are added to automotive forging steels for several purposes, the chief of which is to increase the hardenability in order to secure greater response to the quenching of large sections. The limiting size beyond which alloys are required to secure thorough hardening on quenching depends on the carbon content of the steel and on the severity of the quench, but usually is about ½-in. diameter with a carbon content of 0.40 per cent. Alloy steels often are preferred for parts tempered to higher hardness values, the actual borderline depending largely on the type of stress involved. Alloys are used also for improving properties other than tensile and impact, such as resistance to corrosion and erosion, creep at high temperatures, impact at low temperatures, and wear and abrasion. Another common reason for employing alloy steels for automotive forgings is the closer control and inspection exercised during their making, which result in fewer rejections during fabrication at customer's plants. For example, Willys-Overland has consistently used alloy steel for steering gear parts for many years regardless of the calculated stresses because no failures in these parts can be tolerated.

It is now generally recognized that steels of different chemical compositions possess the same tensile properties (tensile and yield strengths, elongation, and reduction of area) when thoroughly hardened and then tempered to the same hardness, at least below 400 brinell. The impact and fatigue strengths of such steels are also more or less independent of their analyses. As a result it generally is agreed that steels of equal hardenability may be safely interchanged as far as tensile properties are concerned, providing they are tempered to the same hardness. The hardenability of a proposed new grade can be predicted with a fair degree of accuracy from its composition. To a large extent therefore the choice of alloying elements for increasing hardenability depends on commercial factors such as cost and availability, although certain limitations and preferences result from metallurgical considerations. For example, steels containing

more than 2 per cent manganese are inclined to be brittle, particularly if the carbon is high. Nickel and silicon possess considerably less hardening power than some other alloys, so that silicon is principally used for deoxidation alone, while nickel most often is used in combination with chromium or molybdenum, or both. Chromium, like manganese, imparts brittleness when present in large amounts, and therefore is combined with such elements as nickel, molybdenum, and vanadium in the more highly alloyed constructional steels.

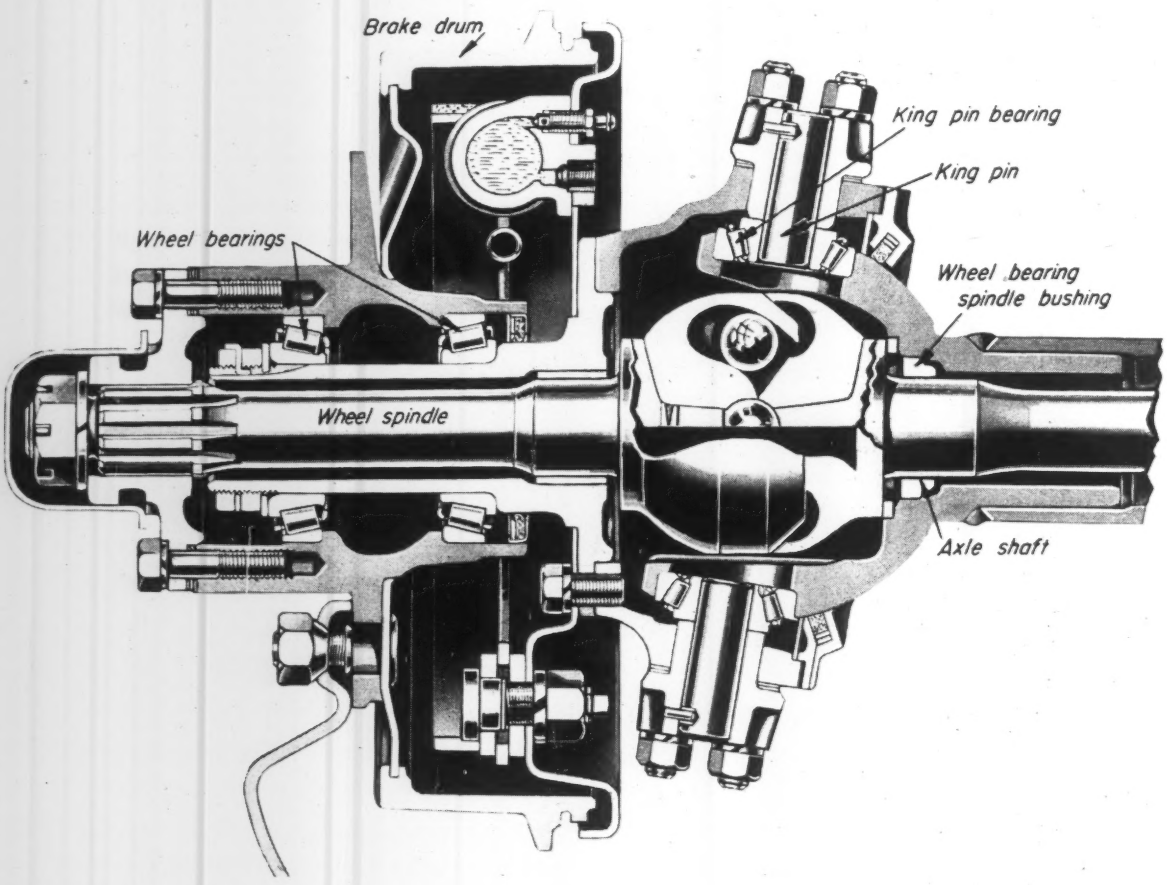
Alloys also differ greatly in their effect on properties such as creep and corrosion resistance. For instance, nickel and copper are employed for improving corrosion resistance, molybdenum for creep resistance, and nickel and molybdenum for toughness at low temperatures. The alloying elements further affect to varying degrees the fabricating characteristics such as rolling, forming, deep drawing, forging, machining, and heat treatment. Generally speaking, alloy steels are more difficult to fabricate than plain carbon steels, and the greater cost of these operations must be considered in addition to the increased price of the raw materials. The higher the properties required in the finished part, the greater the difficulty of shaping it into final form.

THOROUGH-HARDENING ALLOY STEEL FORGINGS: Principal forgings in the Jeep made of the so-called thorough-hardening alloy steels include the Pitman arm, steering arms, drag-link bell crank, spring clips, intake valves, rear axle shafts, and Tracta front axle shafts and wheel spindles. In all of these parts except the intake valves, alloy steels are used solely for the purpose of increasing the hardenability. They are all quenched in oil, and most are tempered to a mean hardness of 300 to 360 brinell. Carbon contents from 0.37 to 0.42 per cent have been successfully used at one time or another. The "P" value* and impact strength are not appreciably affected by carbon content in this neighborhood, which affords a reasonable margin of safety on quenching. Fine grain size (ASTM Rating Nos. 5 to 8) is specified, in order to secure maximum "P" value and to avoid grain growth on heat treatment. Wherever possible, the steel is purchased according to guaranteed hardenability limits because they are narrower than those obtained by using the chemical specification alone. Open hearth rather than electric furnace steel is employed for all alloy steel parts in the Jeep except those made from stainless steels, namely, the exhaust valve heads and the heat control valve shaft.

A variety of optional grades of steel originally were specified for these forgings, principally 1340 (0.40 per cent carbon, 1.75 per cent manganese), 4042 (0.42 per cent carbon, 0.25 per cent molybdenum), and 5140 (0.40 per cent carbon, 0.80 per cent chromium) for the low stressed parts, and 3140 (0.40 per cent carbon, 1.25 per cent nickel, 0.65 per cent chromium) and 4140 (0.40 per cent carbon, 1.00 per cent chromium, 0.20 per cent molybdenum) for the highly stressed parts. The options afford flexibility under changing conditions of price and availabil-

*"Selecting Materials for the Jeep," Part I, MACHINE DESIGN, Oct., 1945.

Fig. 1—Front wheel, showing Bendix-Weiss universal joint. Brakedrum is gray cast iron. Axle shaft, wheel spindle and king pins are carburized alloy-steel forgings



ity, the former being emphasized in peacetime, the latter in wartime. With the advent of wartime shortages of ferroalloys, the triple-alloy National Emergency steels were introduced, being formulated in such a way as to reduce to a minimum the additions of virgin materials by making the greatest possible use of the nickel, chromium and molybdenum residuals, which would otherwise be undesirable. In general, the 8600 and 8700 series have been well received by both producers and consumers. On the other hand, the 9400 series has met with some disfavor among producers because residuals frequently exceeded maximum alloy contents, necessitating diversion of heats, and among consumers chiefly because of the high cost and low hardenability. However, metallurgical and dynamometer tests showed that all three series were capable of meeting every requirement of the Jeep for thorough-hardening alloy steels.

Cost Affects Popularity of Steels

Predictions as to which grades of alloy steels will be the most popular during the postwar era can only be tentative at present, since their relative prices are subject to revision. The 8600 and 8700 series already have joined the ranks of the standard alloy steels, and no longer are considered merely wartime substitutes. Their present prices, however, are hardly justified by their hardenability and other properties. At present the price of the 9400 series is higher than the 8600 and 8700 series, which will be illogical when the residuals have been sufficiently lowered through dilution of scrap by pig iron. The trend toward single-alloy steels will be due to the speed and simplicity with which they can be produced. The trend in the opposite direction will be governed by the amounts of the residuals, taking into account the paradox that a steel containing several different alloys of equal hardening power has greater hardenability that one containing the same total amount of any one of them. The relative merits of nickel, chromium, vanadium, and other ferroalloys for improving hardenability and other properties can be argued at length, but the deciding factor will be the effect on the cost of the finished part. Surveys have shown that a larger ratio of electric furnace to open hearth alloy steel may be anticipated for postwar as compared with prewar. However, it is doubtful whether the automotive industry will share this increase in the use of electric-furnace steel, at least unless the price is made sufficiently comparable to that of open-hearth steel, a possibility that appears unlikely.

Another important unknown is the future price of the "special-addition-agent" (S.A.A.) steels, which are made by adding such materials as Grainal and Ferro-Boron to plain carbon and alloy steel. The principal use of these agents is to improve hardenability, and their popularity for this purpose will likewise depend on their effect on the cost of the finished part. They possess an advantage over other alloying elements in that they do not affect the fabricating properties, so that they may offer considerable economies when substituted for conventional alloy steels of equal hardenability. In the case of the Jeep, plain carbon S.A.A. steels probably would suffice, since the leanest of the present alloy steels are satisfactory. S.A.A. steels also show some advantages as regards physical properties when compared with conventional steels,

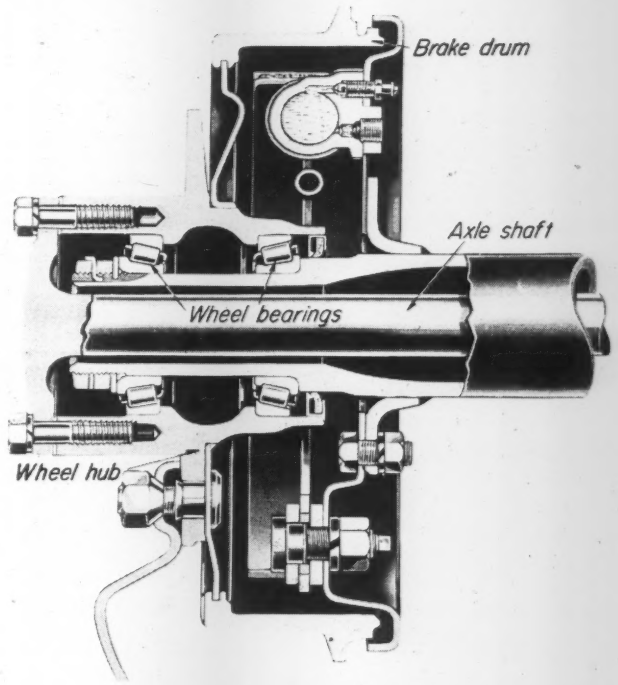


Fig. 2—Rear wheel axle shaft is forged alloy steel because good hardenability is needed. Wheel hub is cast malleable iron and brakedrum is cast gray iron

namely, greater toughness at high hardnesses and slightly increased "P" values at all hardnesses.

CARBURIZED ALLOY STEEL FORGINGS: Principal carburized alloy steel forgings in the Jeep are the transmission gears, transfer case gears and shafts, differential gears and shafts, hypoid ring gears and pinions, king pins, Tracta male and female joints, and Bendix-Weiss front axle shafts and wheel spindles. Alloy steels are used for these parts because their sections are too large to harden otherwise on quenching, in view of the low carbon content; the core hardness must be adequate to support the case. Moreover, alloy steels are sold as being of guaranteed carburizing quality. Fine-grained steels are specified to avoid the necessity of double quenching. Most of the parts are gas carburized to a mean case depth of about 0.030 to 0.040-inch, and then quenched in oil—often with fixtures—without reheating. They finally are tempered at about 300 to 400 F, yielding a hardness in the neighborhood of 60 rockwell C. Apart from chemistry and grain size, inspection specifications are confined to case depth and hardness. At the same time, gears have been among the most difficult problems in automotive metallurgy, so that extensive dynamometer and other tests must be made before any substantial change in materials or design is approved. Pitting, scuffing, and chipping, rather than actual breakage, are the chief causes of failure on these tests.

Prior to the war, 4027 (0.27 per cent carbon, 0.25 per cent molybdenum) and 4620 (0.20 per cent carbon, 1.75 per cent nickel, 0.25 per cent molybdenum) were the grades most commonly used for carburized alloy-steel forgings. Carbon contents of the 4000, or Amola, series generally are higher than in other grades because of the low alloy content and because the hardenability is further decreased by the extremely fine grain size resulting from the

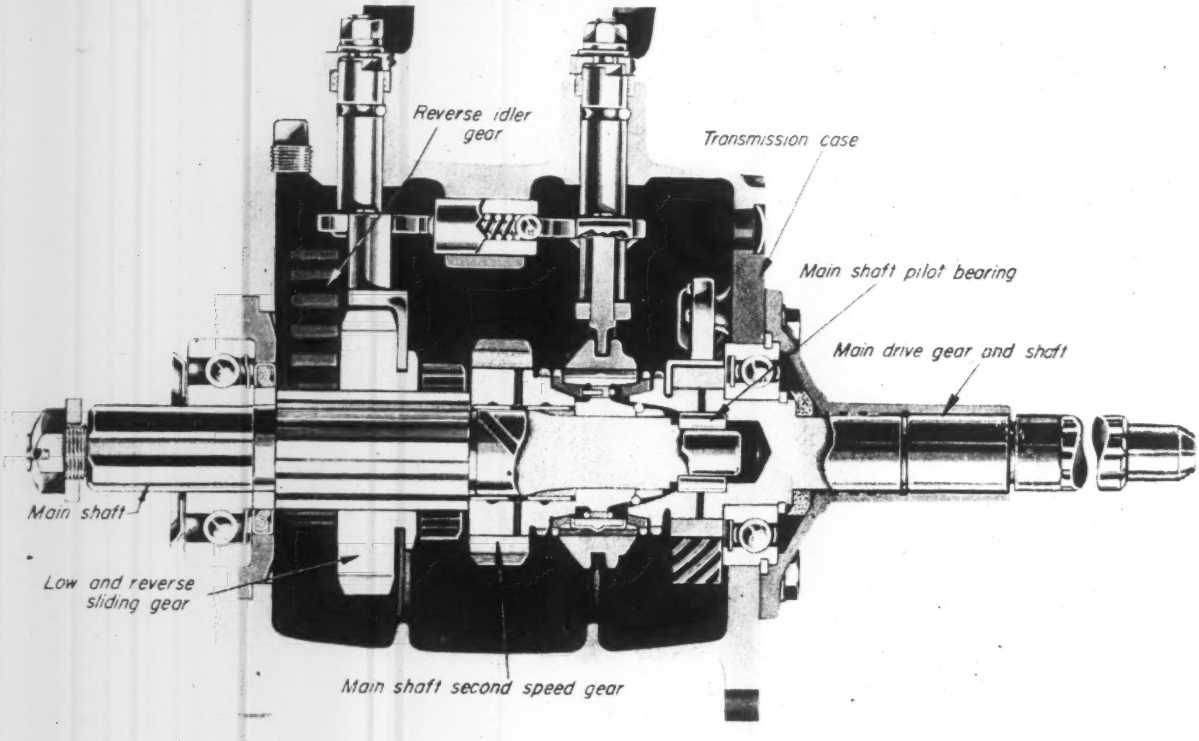


Fig. 3—Jeep transmission contains forged carburized alloy-steel reverse idler gear, main drive gear and shaft, mainshaft, low-and-reverse sliding gear, and mainshaft second-speed gear. Case is gray cast iron

molybdenum content. More recently 8620, 8720, and 9420 (all 0.20 per cent carbon) have been used for all parts in this category with excellent results, as in the case of the thorough-hardening alloy-steel forgings. Again, two or more optional grades are specified for each part for the sake of flexibility. Costs will be the predominant factor in deciding which steels will be preferred during the postwar period. S.A.A. steels would appear to be particularly useful for carburized parts, since they possess high impact resistance at high hardnesses. At present, however, this possibility has not been sufficiently confirmed by actual experience.

BOLTS, SCREWS, AND STUDS: As far as possible, stock items of bolts, screws, and studs made for the trade are utilized in the Jeep in the interests of cost and availability. In the lowest category of these parts no chemical or physical properties are specified. Generally 1010 steel (0.10 per cent carbon, 0.40 per cent manganese) is used if the parts are to have rolled threads and upset heads, while 1112 steel (Bessemer screw stock) is used if the design is such that rolling or upsetting is impossible so that machining is required instead. In the intermediate classes, medium-carbon unalloyed steels are used, with maximum and minimum hardness limits stipulated. In some cases these parts are hardened and tempered, while in others they are merely stress-relieved after cold working.

Hardened and tempered alloy steel is required for the highest class of these parts, for which stock items are less frequently used and for which material specifications must therefore often be written by Willys-Overland. Locations in which these parts are used include the connecting rod cap, crankshaft bearing caps, generator support insulator, cylinder head, steering arm, and axle shaft flange. Fine-grained alloy steel with 0.37 to 0.40 per cent carbon range is specified, almost any of the regular alloy grades being adequate. The parts are hardened and usually tempered to 321 to 375 brinell. Where possible, a standard or subsize specimen is cut from the bolt for complete tensile testing; otherwise the test for tensile strength is performed on the part itself without special machining. In the latter event, experience has shown that the minimum tensile strength in pounds of a new part can be predicted from the formula: (Minimum brinell $\times$ 500 $-$ 5000) $\times$ (Mean of Pitch and Root Cross-Sectional Areas). In these cases, the yield strength seldom can be determined, and ductility is specified by means of a bend test or an impact test in which the part, without special machining, is clamped and struck as in the Izod test. Decarburization is not specified at present since no difficulty has been experienced from this source. However, data have been accumulated so that decarburization may be specified at any time it appears advisable.

In some instances the performance of bolts, screws and studs has little connection with the calculated stresses and physical properties, due to high initial tension imposed during assembly. This tension must therefore be controlled, and a torque wrench gives an approximation that suffices for most automotive work, though errors are caused by the varying amounts of friction between the mating threads. Where this error cannot be tolerated, as in some aircraft assemblies, the initial stress must be determined by an extensometer applied to the part under tension.

CASTINGS: Three main types of castings are used in the automotive industry: Steel, malleable iron, and gray iron. In addition several materials, many of them trade named, are available that border on these classifications, such as graphitic steel and pearlitic malleable iron. For the castings, only gray and malleable iron are used in the basic Jeep, although steel is used on some auxiliary equipment.

Steel and a larger proportion of malleable iron are used in heavier vehicles, but the present materials have proved satisfactory for the Jeep even under the severest conditions of service. The main reason for this fact is that the stresses in many Jeep castings are relatively low, because the sections must be made thick enough to permit proper flow of the metal in the mold.

Why Castings Are Used

Intricacy of design is the usual reason for selection of the casting process. There is little prospect of the replacement of castings by weldments in the automotive as in the heavy machinery industry, at least as far as the lighter vehicles are concerned. Such substitutions usually are economical only in comparatively large parts. It is commonly said that gray cast iron is so brittle that it should be used only where no impact resistance is required. However, the material possesses sufficient toughness for many automotive parts and, in the remainder, strength is an important consideration for preferring malleable iron; the same is true in comparing malleable iron with cast steel. Malleable and particularly gray iron possess an important advantage over steel in their resistance to wear; the exposed particles of graphite are soon dislodged, forming pockets that hold the lubricant. Both kinds of cast iron also have excellent machinability.

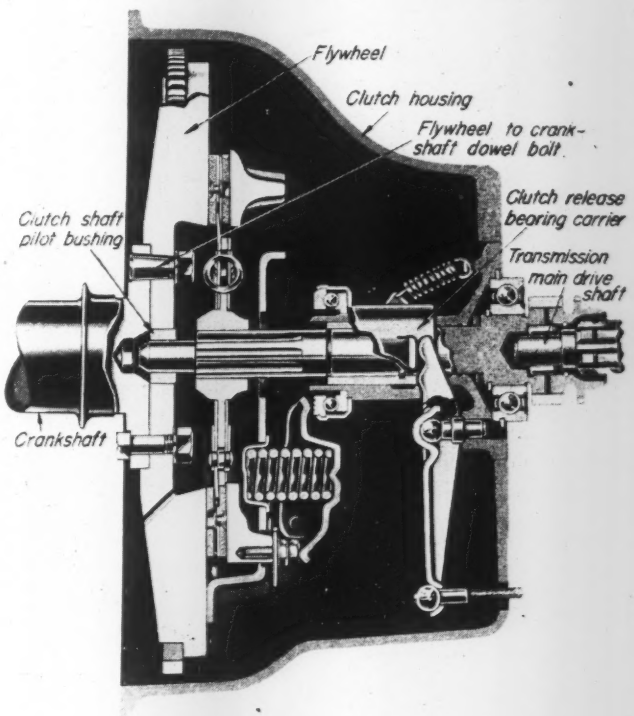
Malleable iron castings in the basic Jeep are the wheel hubs, front and rear differential housing, and brake and clutch pedals. Recently, normalized forged steel AISI C-1141 (0.40 per cent carbon, 1.50 per cent manganese, 0.10 per cent sulfur) has been substituted temporarily in the pedals on account of a shortage of foundry capacity and the availability of hammer capacity. All malleable iron castings belong essentially to one grade, and have minimum physical properties in the neighborhood of 50,000 psi tensile strength, 32,000 psi yield strength, and 10 per cent elongation in 2 inches. Chemistry is not specified.

The large number of gray iron castings in the Jeep includes the cylinder block and head, piston rings, camshaft, intake and exhaust manifolds, water pump body and impeller, oil pump body and cover, clutch housing and release bearing carrier, transmission case, transfer case housing, flywheel, and brake drums. These parts fall substantially into two classes: Those in which strength is not an important factor, so that machinability is the prime consideration; and those in which strength and other physical properties take precedence over machinability. In the former class, only a maximum hardness in the region of 180 brinell is specified, as compared with a range of about 180 to 220 brinell in the latter. Both local and overall uniformity of hardness are essential for good machinability; annealing may be required for this purpose, but this operation is at the discretion of the foundry, providing machinability and physical properties are satisfactory. Chemical analysis is specified with relatively broad ranges, since a particular composition is not required for any given application. Use of inoculants is also optional with the foundry. Occasional tests are made of the physical properties of sample test bars, including tensile strength, transverse strength and transverse deflection. Microstructure is also an excellent indication of the quality of gray cast iron, the shape, size, and distribution of the graphite particles being particularly important.

Two cast iron parts, the piston rings and camshaft, differ considerably from the foregoing description. The piston rings contain about 0.35 per cent phosphorus for greater wear resistance, the hardness being 98 to 106 rockwell B (228 to 293 brinell). Modulus of elasticity, which in cast iron depends on the form of the graphite particles, is controlled by specifying the force required to close the gap in the rings. The camshaft is the only alloyed casting in the Jeep, for which 0.30 per cent nickel, 0.75 per cent chromium, and 0.50 per cent molybdenum; or 0.90 per cent chromium, 0.50 per cent molybdenum, and 0.60 per cent copper are optional. Hardness is 262 to 293 brinell except on the cam lifts and fuel pump eccentric, which are chill cast to produce a minimum hardness of 65 shore sceleroscope (461 brinell).

Bearings, Bushings, and Thrust Washers: The most critical bearings in the Jeep, as in all automotive vehicles, are the connecting rod and crankshaft main bearings. Prior to the tin shortage, tin-base babbitt containing 7.5 per cent antimony, 3.25 per cent copper and remainder tin, was used. Since that time lead-base babbitt containing 15 per cent antimony, 0.5 per cent copper, 1 per cent tin, 1 per cent arsenic and remainder lead, has been substituted. It generally is agreed that the main characteristics required in a bearing metal are embedability, fatigue strength, and resistance to scoring and corrosion. Wear is a problem only if these requirements are not fully met and an ample supply of clean and proper lubricant is not present. Both tin and lead-base babbitts show excellent performance as

Fig. 4—Intricacy of shape is primary reason for use of gray iron castings for clutch members such as the housing, release-bearing carrier and flywheel. Other materials used are: Forged plain-carbon steel for crankshaft, sintered bronze for clutch-shaft pilot bushing, forged carburized alloy-steel for transmission main driveshaft, and alloy steel for flywheel-to-crankshaft dowel bolt



regards all of these properties except that fatigue strength is relatively low. The bearing metal, only about 0.005-inch thick in the finished parts, is therefore cast onto a backing strip of 1010 steel, a construction that has proved entirely adequate. The use of a thin layer of soft alloy supported by a wrought or cast backing, often with an intermediate material for better bonding and reinforcement, represents a definite trend in the metallurgy of bearings. Unlike most aircraft-type bearing materials, both babbitts have the advantage of being usable with crankshaft journals tempered below 300 brinell.

The Jeep piston pin is locked in the connecting rod and floats in the aluminum piston without an intermediate bushing. The pin hole of the piston is diamond-bored to a high finish and the part then tin plated all over. The pin is ground to a fine finish and selectively fitted to the piston.

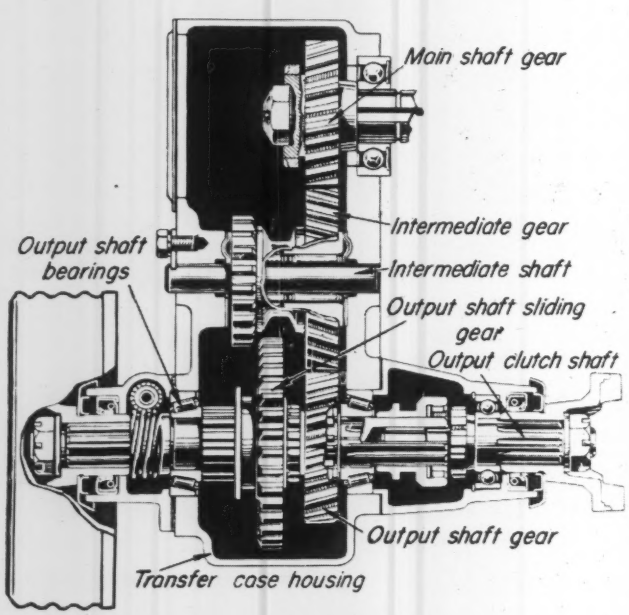
Ball and roller bearings in units transmitting power to the wheels, and in the wheel bearings, are stock items, the metallurgy of which has been developed by the bearing manufacturers. In some bearings, the races and balls or rollers are made from 52100 steel (1.00 per cent carbon, 1.35 per cent chromium), hardened and tempered to a minimum of about 60 rockwell C. In the remainder these parts are made from 4620 steel (0.20 per cent carbon, 1.75 per cent nickel, 0.25 per cent molybdenum), carburized, hardened, and tempered also to a minimum of about 60 rockwell C. During the war 4720 steel (0.20 per cent carbon, 1.00 per cent nickel, 0.50 per cent chromium, 0.20 per cent molybdenum) was formulated specifically for these applications and successfully substituted.

Bronze containing 10 per cent tin, 10 per cent lead and remainder copper, is used in the most highly stressed cast bushings such as the front wheel bearing spindle and transmission countershaft bushings. It was used in the latter only in the military Jeep, being replaced by needle bearings in the larger transmission of the civilian Jeep. Sintered bronze containing 10 per cent tin, remainder copper, is used in the clutch shaft and Bendix starter pilot bushings. A drawback of sintered metals for some high-duty applications, such as spring shackle bushings, appears to be their lack of resistance to crushing under impact.

The crankshaft thrust washer is made of 1045 steel (0.45 per cent carbon, 0.75 per cent manganese), hardened and tempered to 207 to 255 brinell. Other thrust washers, as in transmission, transfer case, and front wheel universal joints, are made of bronze.

SURFACE TREATMENTS: Some of the most important of recent developments in metallurgy include surface treatments of three kinds: Those that increase fatigue strength by means of compressive residual stresses on the surface; those that reduce wear by pitting or roughening the surface so as to hold the lubricant; and those that provide a soft coating with superior breaking-in characteristics.

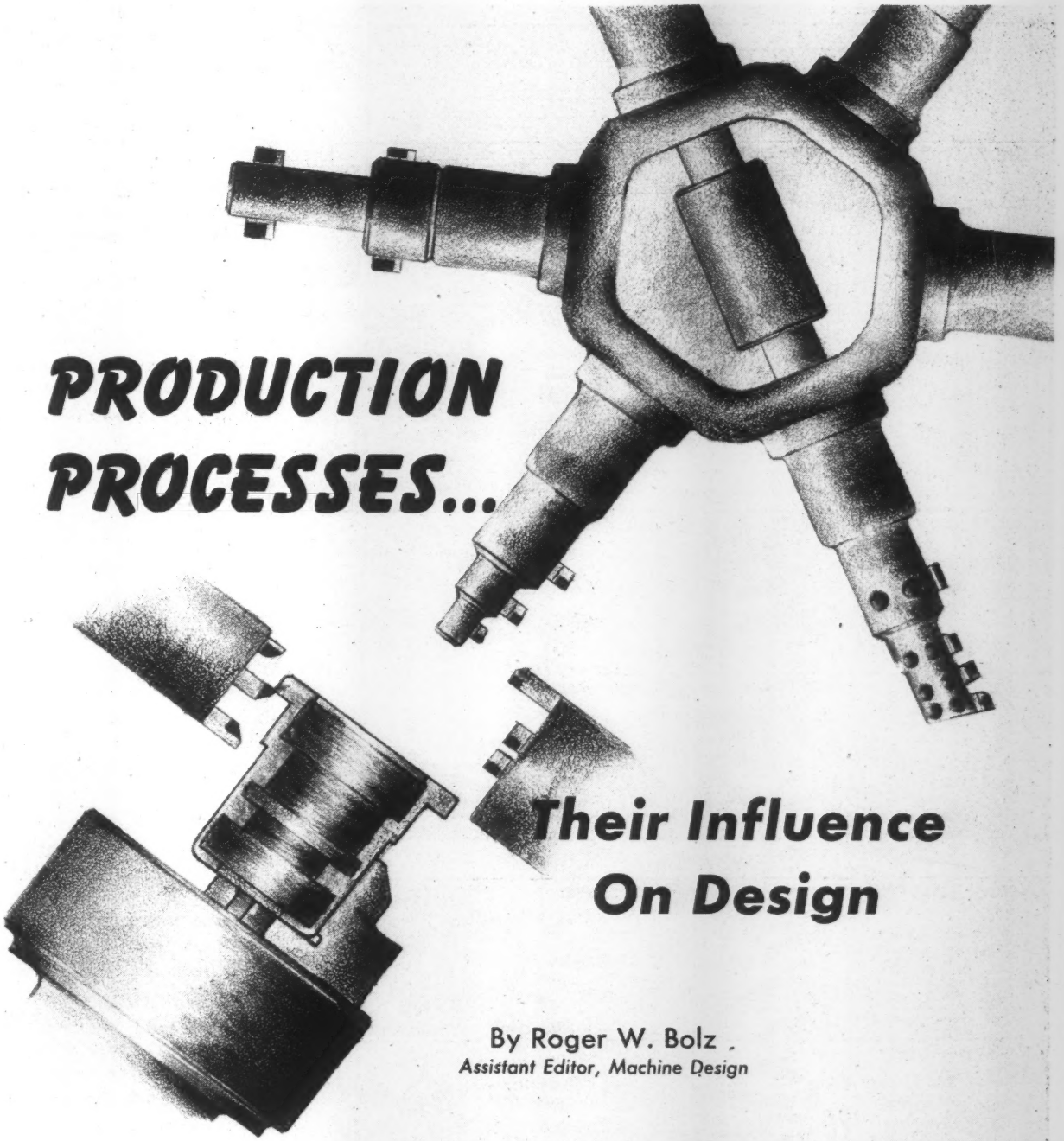
Fig. 5—Jeep transfer-case assembly. Carburized alloy-steel forgings are used for all parts indicated by arrows with the exception of the transfer-case housing and the bearings. Housing is gray iron casting



Shot Peening Seeing Increased Use

The principal method in the first category is shot peening, which during the war was applied to an increasing amount of materiel. Parts of the Jeep treated in this manner are the tension sides of the two upper leaves of each chassis spring, the valve springs, and the yokes of the Tracta front axle universal joints. In the case of the chassis springs, for example, the intensity of peening is specified as 0.012-0.015 A2, meaning 0.012 to 0.015 reading on No. 2 Almen gage, using the "A" test strip. The lives of these parts were increased several hundred per cent by this treatment. It is interesting to compare this method, which leaves a roughened surface, with the use of polishing and superfinishing to increase fatigue strength by eliminating stress raisers. A method that has some peening effect and at the same time provides any desired degree of finish is vapor blasting, in which a jet of abrasive sand or crushed rock suspended in a water emulsion is directed under high pressure against the surface. Sandblasting used to clean forgings has the same effect to a minor degree, although it is preferred to pickling for other reasons. Nitriding is a chemical means of achieving the same purpose, though this is not the only reason for its use.

The way in which the pitted surface of cast iron serves to hold the lubricant and reduce wear already has been mentioned. Shot-peened surfaces also possess this property. However, another method is used to maintain a film of grease between the flat sliding surfaces of the Tracta front wheel universal joints, namely the formation of a complex phosphate coating by means of the Parco Lubrite process. Still another method is hard chromium plating, which in the Jeep is applied to the shock absorber piston rod and carburetor throttle valve shaft. A variant of this process is the Van der Horst method, in which the current is reversed after plating, so that the fissures in the surface of the plate are enlarged. This method has proved beneficial in some engines when applied to the piston rings or cylinder bores, but the full scope of its application has yet to be determined. The limit in treatments of this kind is reached in sintered and sprayed metal coatings, which are sufficiently porous to hold reservoirs of lubricant.



PRODUCTION PROCESSES...

Their Influence On Design

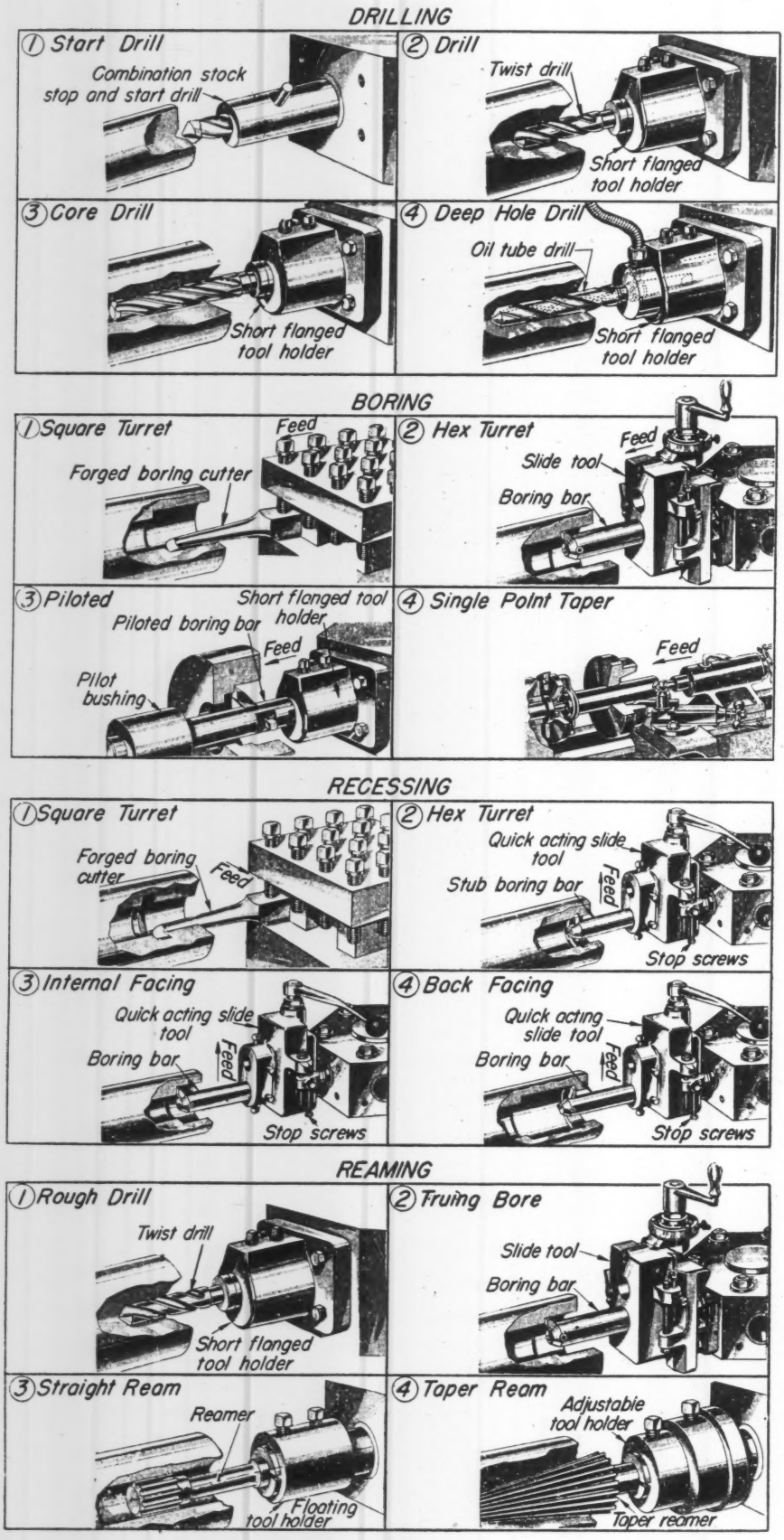
By Roger W. Bolz
Assistant Editor, Machine Design

Part V—Turret Lathe Machining

PRODUCTION machining equipment is being evaluated more than ever before in terms of "ability to repeat accurately and rapidly". Applying this criterion for establishing the production qualifications of a specific method the turret lathe merits a high rating. A natural outgrowth of the old, well-known engine lathe, the turret lathe can handle either bar or chucking work. Although adapted to produce parts economically in quantities too limited to be suitable for the automatic screw machine, the turret lathe is primarily suited for parts not within the capacity of the screw machine. These might be unusually shaped or heavy forgings or castings requiring large holding fixtures, long complicated shafts, parts where excessively heavy cuts are necessary, and complicated designs with a large number of finished surfaces such as shown in the illustration above. This part is completed in 18 separate machining operations. Basic turret lathe

Fig. 1—Below—Pictures serve to point up versatility of the turret lathe

BASIC INTERNAL OPERATIONS

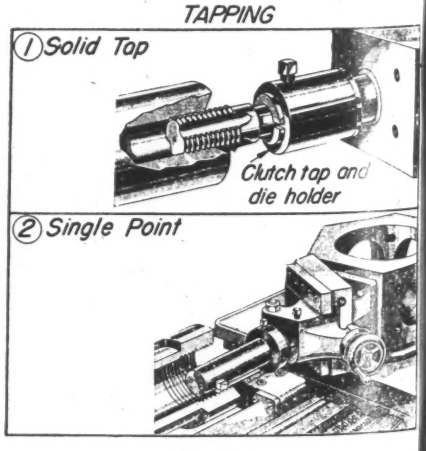


operations and their general sequence of occurrence are illustrated in Figs. 1 and 2. Combinations and specialized variations of these are used to provide rapid, economical production.

Two Machine Styles

Classed among hand-operated or semiautomatic machines, turret lathes fall into two classes—horizontal and vertical. Horizontal machines can be either bar or chucking type with ram or saddle style turrets. Ram style machines have the shortest travel, are lightest in construction and suited primarily to handle bar work or light chucking jobs where the ram overhang can be kept short. Fastest in operation and designed to turn at high speeds, ram style machines can handle with maximum economy bar work from approximately ⅝-inch diameter by 4 inches in length up to as high as 2½-inch diameters by 14 inches in length and chucking work up to 12 inches in diameter (nominal swing may run to 20 inches over bed). The longer stroke, more rigid construction and side-hung carriage of the saddle style machine makes it more suitable for longer and heavier chucking or bar work which requires long turning and boring cuts. Available with a cross sliding turret, the saddle style machine is used for facing deep holes in chuck work where tool overhang would be excessive with other arrangements. It is well adapted for producing internal tapers, contours and threads. Handling capacities may run as high as 12-inch diameter by 48-inch length for bar work and up to 26-inch diameter with a maximum swing of approximately 28 inches over the bed for chucking work.

The vertical turret lathe is similar



in principle to the horizontal but is designed for considerably larger and heavier work. Not in any way adapted to bar work, machines of this type are designed for and will handle complicated chucking work up to 73 inches in length with a maximum swing of about 78 inches.

Large quantity lot manufacture, usually requisite for maximum economy in most methods of production, is not always a necessity. Part adaptability — design for production with minimum tooling and set-up costs— plays the leading role in economical and efficient production.

Since tooling and set-up costs must necessarily be divided between the number of pieces to be produced, small and medium quantity lots require the maximum in design consideration. These costs in low production are, roughly speaking, inversely proportional to the ease with which the part design can be reproduced or sized by standard tools using standard tool holders and work-holding devices. Small lots (3 to 15 pieces) seldom can justify any special tools or holding fixtures. Naturally, medium lot work (15 to 100 pieces) allows a considerably wider range in set-up to reduce production time per piece, but standard tools and holders are most economical wherever design will permit their use rather than the more costly special ones.

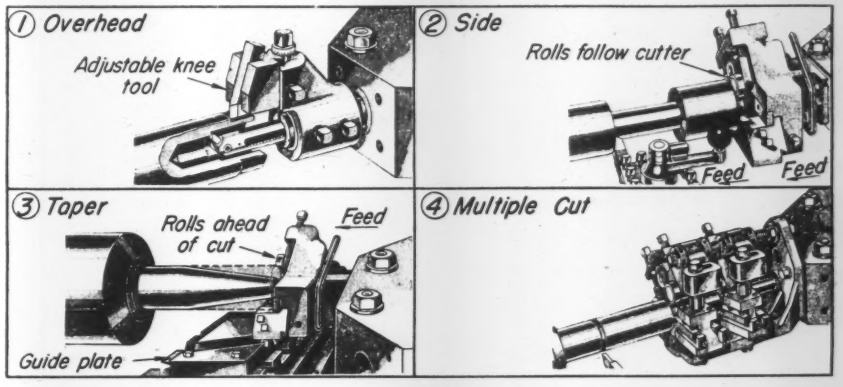
Tooling to Increase Output

On continuous or high production runs, tooling cost becomes an insignificant part of the total cost per piece. Consequently special tools, cutters, clamps, holding fixtures, etc., can be utilized to reduce machining, handling and indexing time. Where unusually

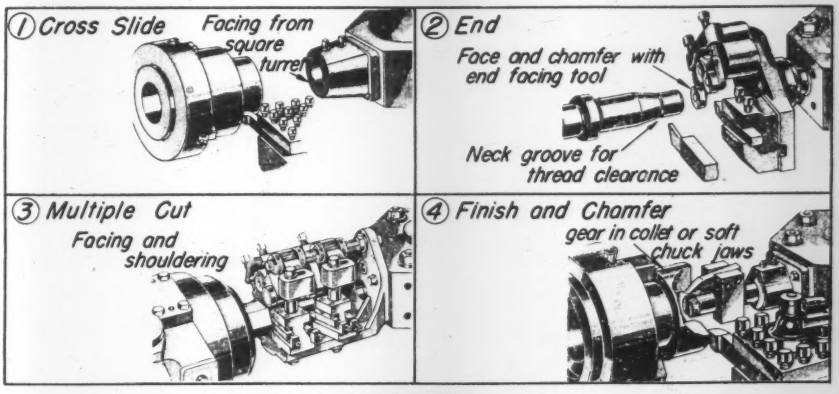
Fig. 2—Below—These pictures illustrate simple external operations which, when used in combination, effect rapid, economical production of parts

BASIC EXTERNAL OPERATIONS

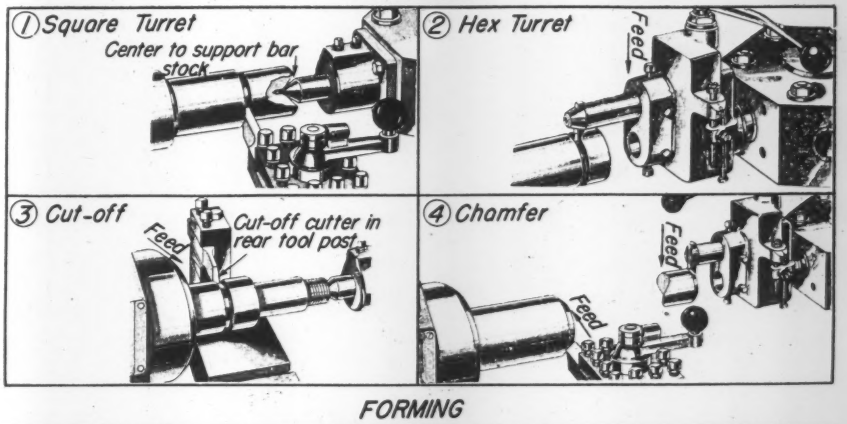
TURNING



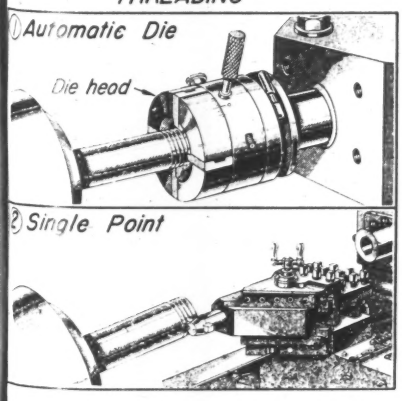
FACING



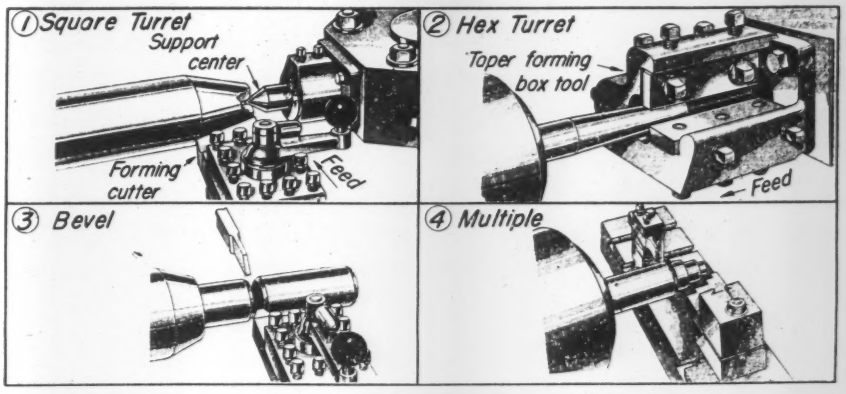
GROOVING



THREADING



FORMING



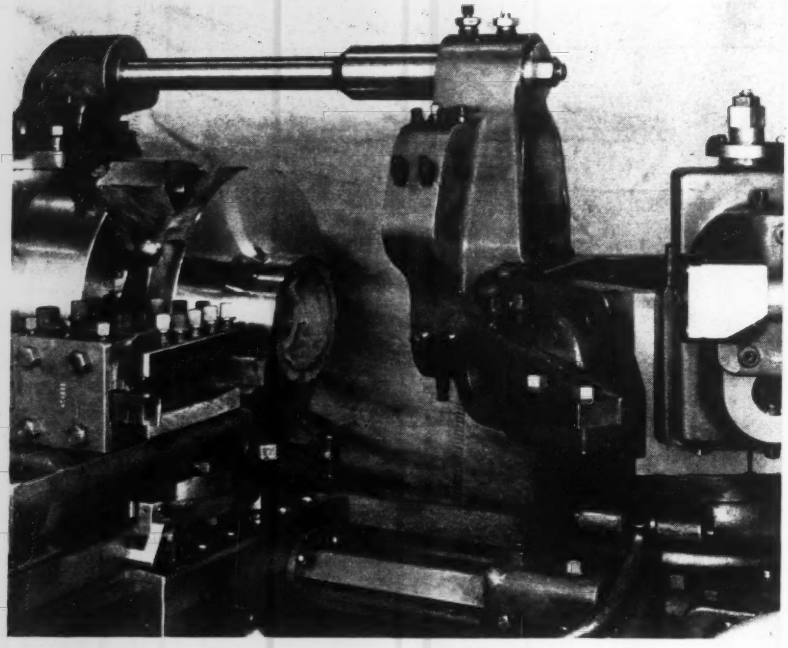


Fig. 3—Left—Square turret on this set-up is cam actuated to generate a smooth curve

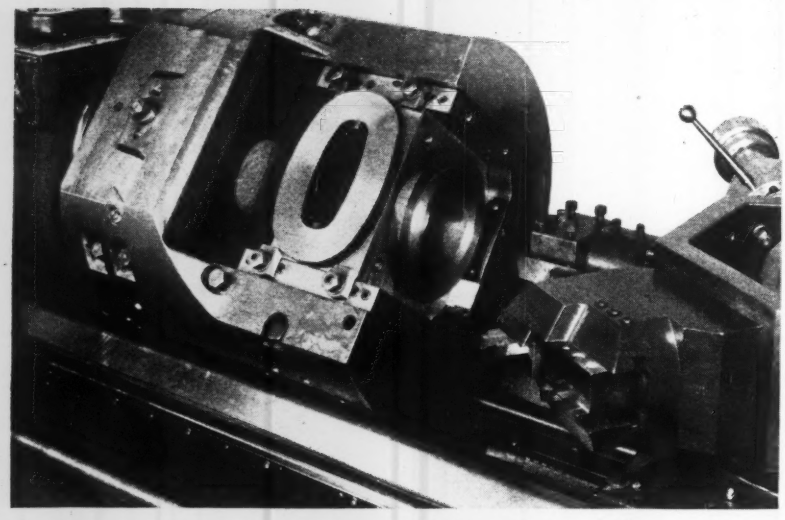


Fig. 4—Left—Special indexing chucks provide for economical production of odd-shaped parts which require accurate, related surfaces

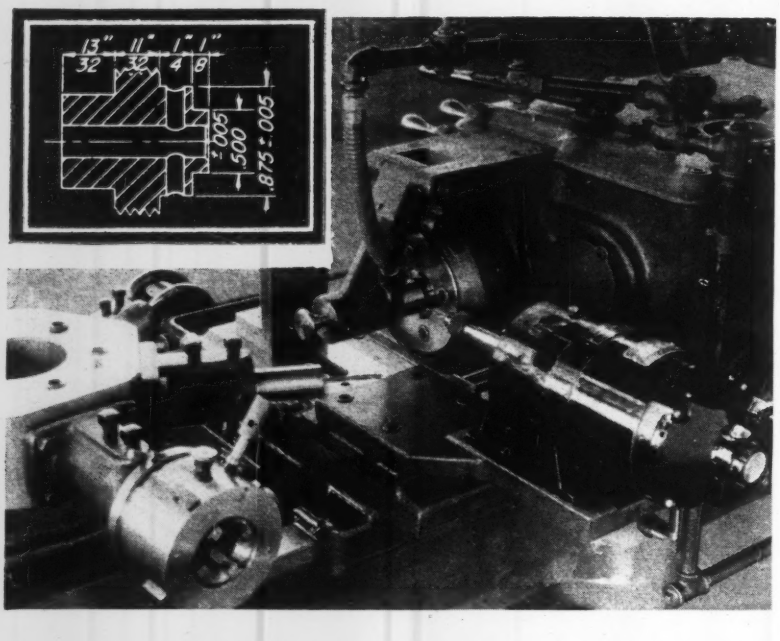


Fig. 5—Left—A swinging jig provides for completion of an accurate and straight cross-hole, obviating a costly second operation

shaped pieces are involved, entirely special units are often designed for the job, *Fig.* 3. Bulky steel valve forgings are handled in special chucks, *Fig.* 4, which allow indexing the part to a number of different positions in order to finish the bore and flange faces, machine and thread the angular seat portions, insert bronze seat rings, and finish machine the seat inserts at the proper angle all at one chucking.

Certain parts, possibly naturals for such as an automatic screw machine, can be produced more economically on the turret lathe owing to the secondary operations which are possible. The stainless steel control valve seat, *Fig.* 5, is such a part. Owing to the fact that the cross-hole had to be located accurately in relation to one face and be perfectly straight, a jig was necessary. Readily adapted to carry both the necessary jig and an auxiliary drilling motor, the turret lathe provides for completion of the part at one handling.

DESIGN: Whenever quantities of individual parts are limited but a great many pieces of a similar nature are necessary, designing for identical tooling can reduce costs effectively. Following this procedure, the cast iron valve pistons, *Fig.* 6, make an ideal turret lathe set-up. Identical design details on all the pistons facilitate tooling and production.

A good objective for the designer to keep in mind during the evolution of a machine part is to design for a minimum number of finishing operations. Machining to size consumes the greatest amount of production time and consequently reduction in the amount of metal to be removed will help considerably to reduce costs. This is true especially with frail parts having thin sections which must, as a rule, be finished with extremely light cuts to avoid distortion. Likewise it follows naturally that the simplest of shapes require the least number of operations and are the easiest to reproduce. Forming,—*Fig.* 2—one of the fastest methods of producing a finished diameter or shape—can be utilized to advantage wherever the length of forming cut does not exceed about 2½ times the smallest diameter of the work. Another objective is ease and speed in chucking the part. Symmetrical castings or forgings are ideal for holding and allow the use of a scroll chuck or

universal air or hydraulic chuck. Where peculiar or frail shapes are necessary, special fixtures must be used to avoid distortion, crushing or movement.

Designing for ease and speed in gripping work is of great importance in production applications. Any handling or loading motion saved is directly multiplied by the number of pieces to be produced. Parts such as five-spoked wheels or pulleys are difficult to grip, therefore if at all possible either four or six spokes should be used. The hand-hole cover, *Fig.* 7, as designed allows little leeway in chucking. Redesigning to provide for internal gripping solved the problem.

So-called chucking extensions are often required in order to provide a practical method of holding. The landing gear fork, *Fig.* 8, is an example showing the use of chucking extensions. These are removed after machining. Such chucking extensions or in certain cases flanges are used on thin walled parts to obviate distortion. In many cases, provision of an extension makes possible completion of the part before cut-off thus speeding production.

Parts which form a portion of a circle sometimes can be produced in multiples to increase output and simplify chucking. The type bar segment, *Fig.* 9, designed as a single piece casting presents both chucking and machining problems. Cast in pairs, however, the blanks are easy to hold. Also machining and accuracy are improved and production is doubled.

Production economy is possible through the utilization of another feature common to the turret lathe—assembly and finish machining of bulky work at one handling. Parts requiring a combination of dissimilar metals finished all over can be handled easily. A bronze seat ring on the cast iron disk shown in *Fig.* 10 is rolled into a machined locking groove under 20,000 pounds pressure and finally finished all over before removal from the machine. Assembly and rolling in of the bronze ring is performed as merely one of the normal turret operations. Broaching from the hex turret has been attempted and is fairly successful with free machining materials such as brass or magnesium. However, it is nominally a hand operation and consequently is not recommended for inclusion in high production work.

Knurls are used much the same as in general screw machine work* but are for the most part limited to bar work. Open-end knurls are most economical and are produced with standard adjustable tools. Proportions of such knurled portions are limited to 2¼ inches in length on bar 3¾ inches in diameter (maximum). Standard pitches available range from 10 to 34 teeth per inch in either straight, diamond or spiral variety.

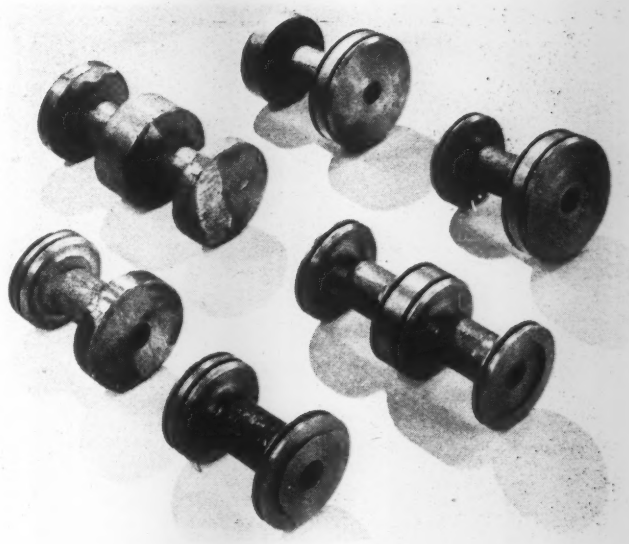


Fig. 6—Above—Designed for identical tooling, various valve pistons shown can be produced at low cost

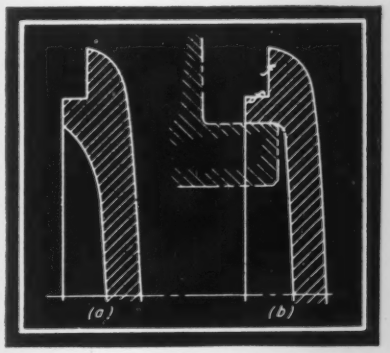
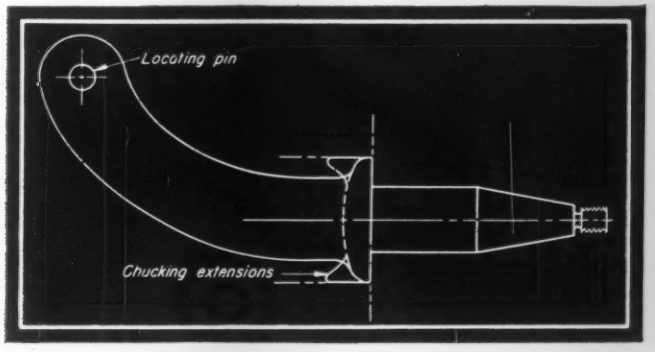


Fig 7—Right—Hand hole cover redesigned as at (b) allows for simple, inexpensive chucking

Fig. 8 — Below — Designed for minimum weight, chucking extensions on this fork are removed after machining



Finish Affects Production

Quality of finish is important. If extreme accuracy or fine finish is necessary the production time is increased. Fine feeds are required to produce a high quality finish. If parts are to be finished by grinding heavy cuts and coarse feeds can be used with good results. With tough materials, fine surface finish may necessitate several finish cuts and in the case of threading, a roughing and a finishing die head.

Die-cut threads are usually preferred to those made with a single-point tool especially when speed and production is imperative. Consequently, it is good practice to avoid parts with threads too long for standard collapsing taps or self-opening dies, not within their standard range or in inaccessible positions. If extremely accurate threads must be produced, the taps or dies can be led on to the work by a lead-on attachment, thereby retaining the production advantages of the automatic tools with the precision of the single-point chasing attachments. All threaded parts designed for production with automatic taps or dies should provide a clearance or neck groove at the end of the thread

*"Production Processes...Their Influence On Design, Part III—Automatic Screw Machining", *Machine Design*, Sept., 1945.

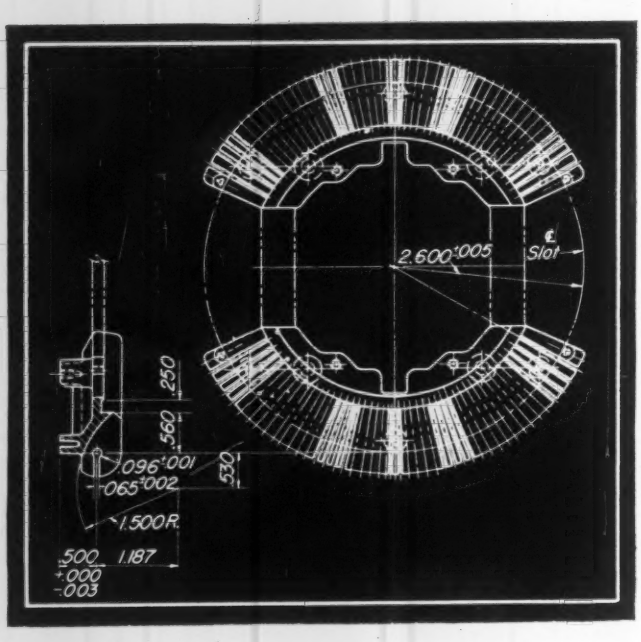


Fig. 9—Above—Produced as a double casting, two type bar segments can be finished complete at one handling. Space between halves allows for entry of special form tooling for the circular groove

of at least 2½ threads in width and 0.010-inch under the minor thread diameter. This allows the self-opening dies or collapsing tap chasers to snap free of the work under no load obviating breakage or chipping of the chasers otherwise often encountered.

MATERIALS: Parts made from castings, forgings, etc., should in all cases provide sufficient material in order that the tools can rough beneath the surface inclusions of sand, pits, scale and hard spots to insure long tool life and good finish. High machinability is, of course, a primary factor and should be taken into consideration in specifying materials. A fairly complete table on relative machinability ratings of various materials was included in Part III of this series. Heat treatment and characteristics of previous processing of the materials are also important in their effect on the machinability.

Commercial brass may be machined at speeds as high as 1000 fpm with carbide tooling but this drops to around 300 with ordinary high-speed-steel tools. Aluminum and bronze likewise can be finished at speeds as high as 1000 fpm. However, aluminum drops to around 400 and bronze to 150 with high-speed tools. High machinability steels such as SAE X1112 are preferred for production jobs owing to excellent finish at high cutting speeds. Hard, semisteel or medium-carbon steel castings may require reduction in cutting speeds to as low as 40 fpm with accompanying low output and higher tool costs.

TOLERANCES: In general, on high production runs where maximum output is both necessary and desirable from a cost angle, a tolerance of plus or minus 0.002-inch is considered a minimum and generally can be maintained with a rough and a finish cut. It is possible to hold overall limits of plus or minus 0.001-inch on turning and boring operations but this is not recommended for production runs because of the additional cuts over the same surfaces and the necessity for fine feeds. A tolerance of plus or minus 0.001-inch can be held on ordinary reaming operations. With additional accurate boring operations preceding reaming tolerances can be held to plus or minus 0.0005 inch.

On parts suitable for the use of a single-cutter roller turner either piloted on the cut being made or on a previously turned surface, a tolerance of plus or minus 0.001-inch can be held. Occasionally it is possible to reduce this to a minimum of plus or minus 0.0006-inch. Multiple-cutter roller turners can be used for turning a number of surfaces simultaneously but the diameter tolerances required are usually wider, being on the order of plus or minus 0.003-inch.

In normal set-up, concentricities of diameters turned can be held within a total dial reading of 0.006-inch with machine and tools in good condition. Roller turners can often be employed to reduce this total runout to around 0.002-inch or somewhat less. Special handling on chucking jobs can also be expected to hold to a total runout of 0.002-inch or somewhat less. Special handling on chucking threaded portions are concentric with other diameters within a total of 0.004-inch. Lead accuracy is usually equal to that required by a class 3 fit as set up by the National Screw Thread Commission. If more accurate threads are necessary, the previously mentioned lead-on attachments can be utilized to attain them.

Standard stop equipment can be relied on to hold limits on lengths within plus or minus 0.001-inch. However, if closer liimts are necessary additional equipment in the form of dial indicators, dial stops or special micrometer stops are required.

Collaboration of the following companies in the preparation of this article is acknowledged with much appreciation: Gisholt Machine Co. (*Figs.* 5, 6 and 10); Jones & Lamson Machine Co.; The Warner & Swasey Co. (*Figs.* 1, 2, 3, 4 and 9).

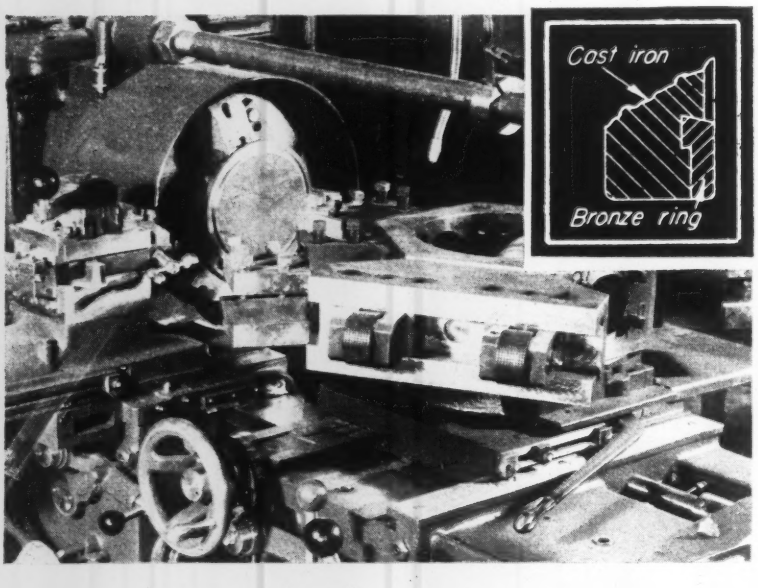
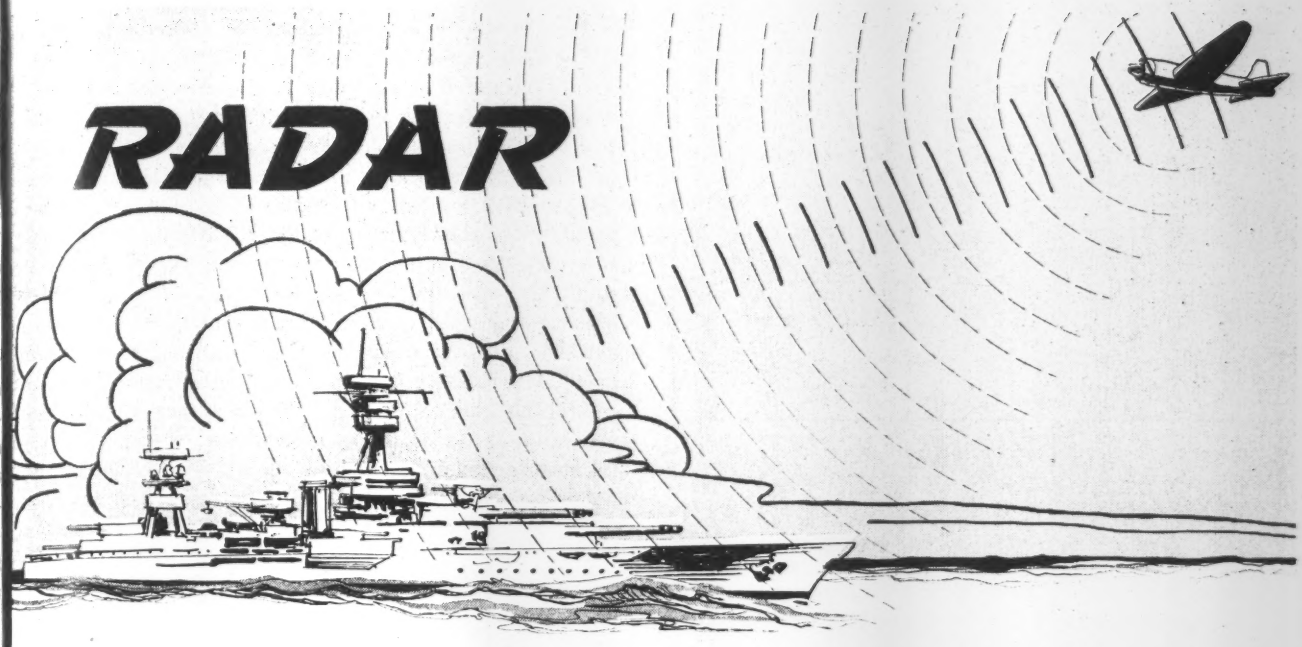


Fig. 10—Left—Locking groove is finished, bronze ring rolled in and entire part machined all over at one handling in the lathe

RADAR



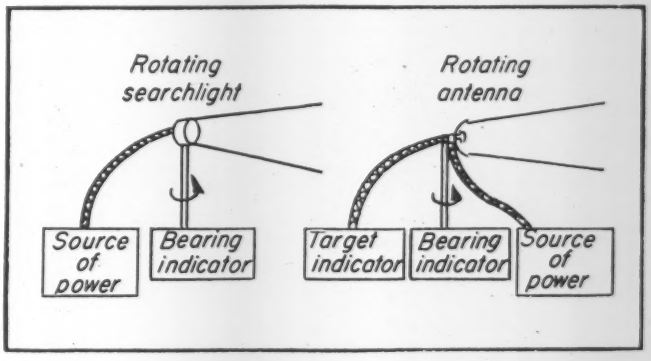
1—Radar operates on the principle of reflection. Heavy lines indicate energy directed from the ship's radiator to the plane. Dashed lines indicate the scattered energy reflected from the plane, only a portion of which returns to the radiator

RADAR—abbreviation for radio detecting and ranging—is based on the simple principle of reflection, familiarly known in the field of sound phenomena as echoing. However, instead of utilizing sound waves, radar employs extremely short radio waves ranging from a few inches to about ten feet in length. These are known also as microwaves and behave much the same as light waves in that they travel in a straight line with comparatively little deviation and can be directed into space as narrow beams by special reflectors.

Many reflectors used in radar are only a foot or two in diameter and are parabolic in shape like the reflector of an automobile headlight. Microwave energy is radiated from a special small antenna mounted in front of the reflector and "beamed" by the reflector in the direction desired. This unit combining the antenna and reflector constitutes a "radiator". Lacking the reflector, the antenna's radiation would disperse more or less uniformly in all directions in much the same manner as does the energy from a transmitting antenna used in commercial radio broadcasting. The antenna, also termed a dipole, consists of nothing more than two lengths of conductor, each a quarter wave length, and may be mounted above the surface of the earth on a beacon, on the mast of a ship, or on a plane.

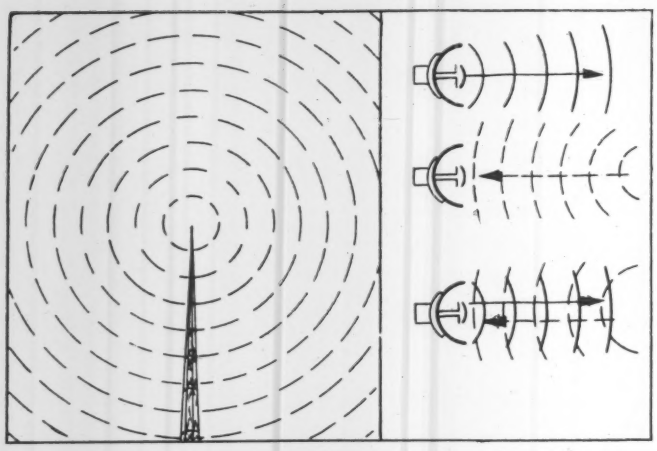
While radar was one of our most potent weapons in the war, much of its potential value in peace yet remains to be explored. The basic principles portrayed are presented in the hope a knowledge of them will stimulate thinking toward more complete utilization of radar throughout industry in the coming years. Various specific design phases of radar will be discussed in articles planned for future issues of MACHINE DESIGN

2—Radar and searchlight systems are similar in principle. In searchlight detection the actual target can be seen by the human eye. Since this is not the case with radar, a target indicating unit must be employed

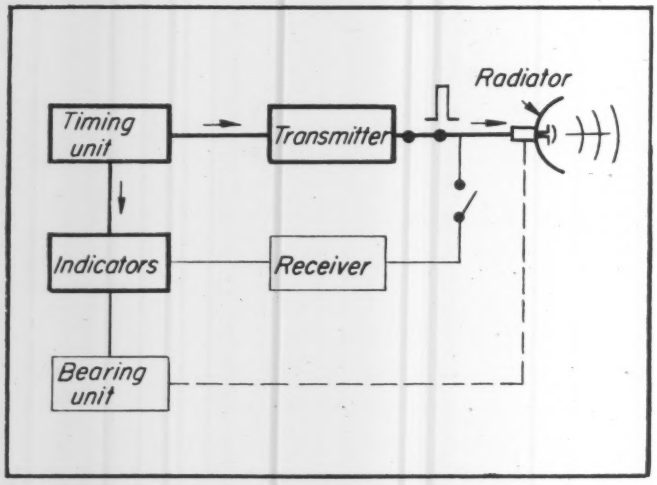


How Radar Detects and Locates: For complete location of a target on the surface of the sea or ground, two quantities must be determined by the radar system and, if the target is in motion—as when enemy ships are in battle maneuvers—these quantities must be indicated continuously. Known as coordinates, these quantities are (1) the distance between the detector and target (range) and (2) the angle made by the target with respect to a horizontal reference line at the detector. This coordinate

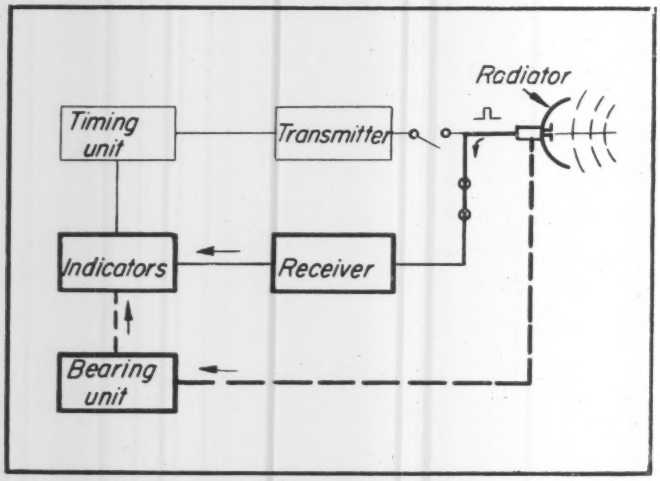
This presentation is based on a report prepared by the research laboratories of Westinghouse Electric Corporation.



3—Commercial radio broadcasting antenna at left radiates energy uniformly. Parabolic radar antenna, however, directs energy into space in the form of a narrow beam



4—Energy from the radar radiator is projected into space in extremely short pulses. During the short period of transmission, the timing unit controls the transmitter so that a suitable pulse is fed to the radiator. At the same time the timing unit triggers the indicators into action



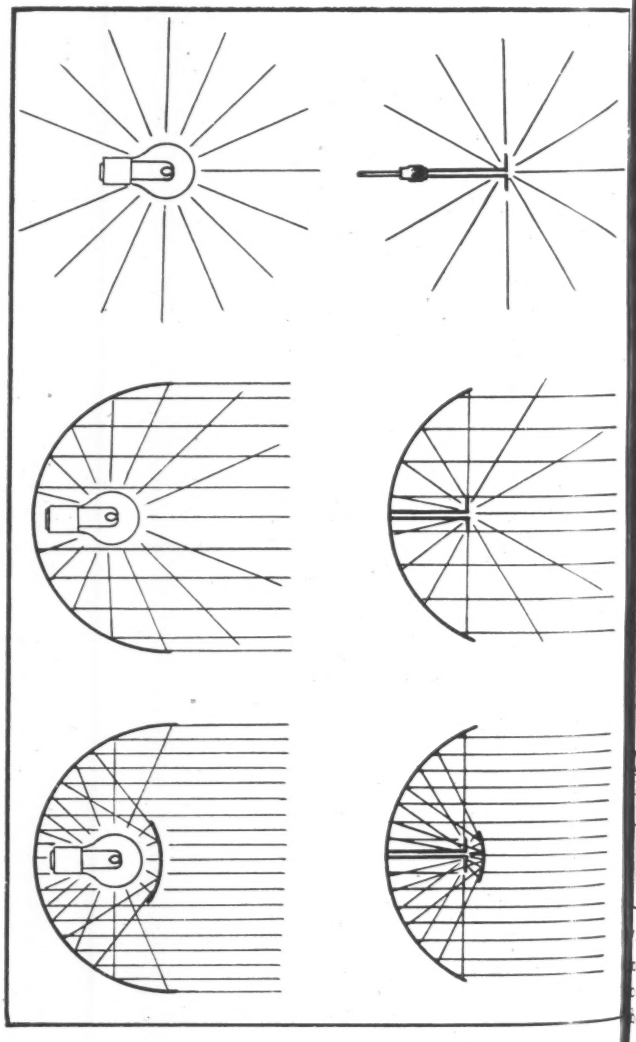
5—The transmitter is inactive after the pulse has been radiated. Reflections returning from the target to the radiator enter the receiver where they are amplified and fed to the indicators. The bearing unit links the rotating antenna to the indicators

is commonly referred to as the bearing angle.

When searching for a target, the radiator is rotated while it sends out its narrow, exploring beam. If the beam strikes a target, the energy hitting the target is reflected and some returns to the receiver. At the receiver, one device (the bearing unit) keeps in step with the rotating radiator and indicates the direction (bearing) of the beam at the instant it reaches the target. Another device measures the time used by the energy in traveling to the target and back again. This time measurement permits determination of the distance to the target (range) since the velocity of the energy is 186,000 miles per second. These two devices, the bearing unit and the timing unit, locate the target. If the target is in the air, a third coordinate also must be determined, i.e., the angle the target makes with the horizontal plane (angle of elevation).

A basic problem that had to be solved in the development of radar was differentiating between the strong transmitted signal and the weak reflected signal. The method which solved this problem, now in general use, is called

6—Function of reflector in searchlight and radar radiator is identical. Bulb and radar antenna without reflectors radiate energy in all directions. With parabolic reflectors much of the energy is directed in narrow beams. Almost all energy is directed in a narrow beam by adding small spherical shield in front of bulb or antenna

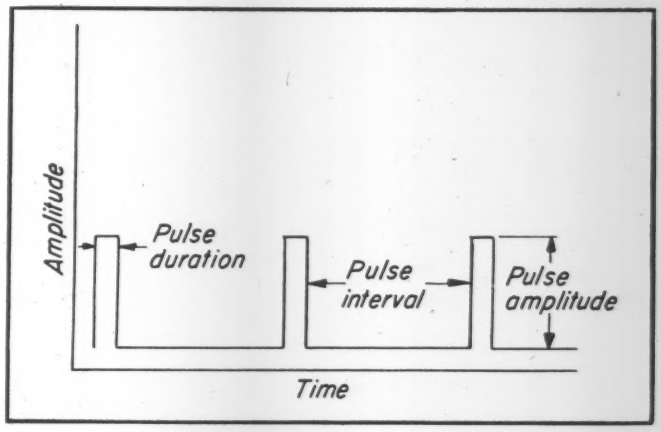


"pulse modulation". This method involves two sequenced steps of operation. First, a short burst or pulse of energy is radiated into space, and next, while the transmitter is inactive, the receiver detects any reflected signals without trouble. This cycle is repeated many times per second.

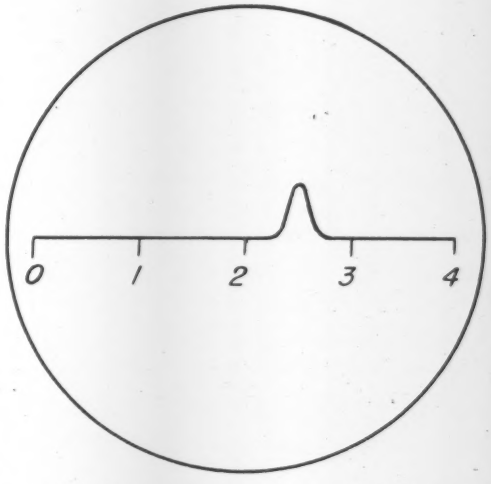
But how long should the transmitted pulse last? And how long should the transmitter be maintained inactive while it waits for the reflected signal? In both cases the range over which the system is to operate determines the values.

The duration or length in time of each pulse is fixed by the shortest range desired since the transmitter must be turned off before the reflected energy returns. This means a very short pulse if targets nearby must be detected, for the velocity of radio waves is so great that the reflection from close targets is almost instantaneous. For example, assuming targets to be detected are 327 yards away, the microwave energy must travel a total of 654 yards to and from the target. Since the velocity of the waves is about 327 yards per microsecond, it will take two microseconds for the round trip. Therefore, the transmitted pulse must last no longer than two microseconds if the receiver is to have a clear channel for the returning signal which generally is very weak. Were the signal to last more than two microseconds, the receiver (even if it could withstand the tremendous power of the transmitted signal) would pick up the outbound signal as well as the reflected signal and the weak, desired signal would be lost in the strong transmitted pulse.

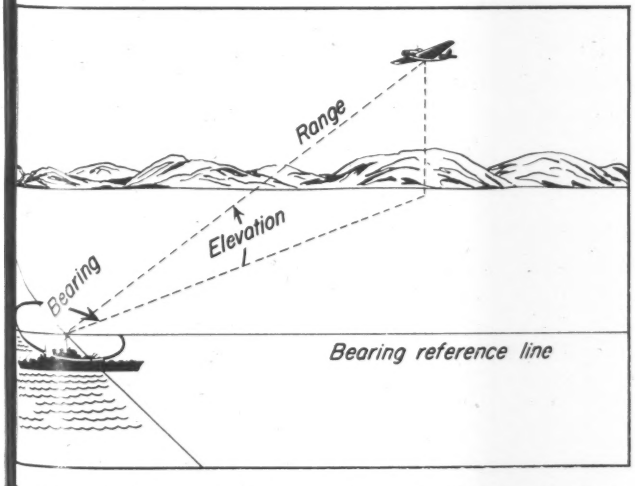
Since the transmitter must remain inactive long enough to permit signals from distant targets to return, the time of transmitter inactivity between pulses, called the pulse interval, is fixed by the longest range desired. Assuming targets 327,000 yards away are to be detected, the microwave energy must travel, altogether, 654,000 yards. At a velocity of 327 yards per microsecond, the total travel time would be 2,000 microseconds (0.002-second). This means that the pulse interval must be 2,000 microseconds to allow the signal to return before another is sent out. Thus, if a system is to detect targets from 327 to 327,000



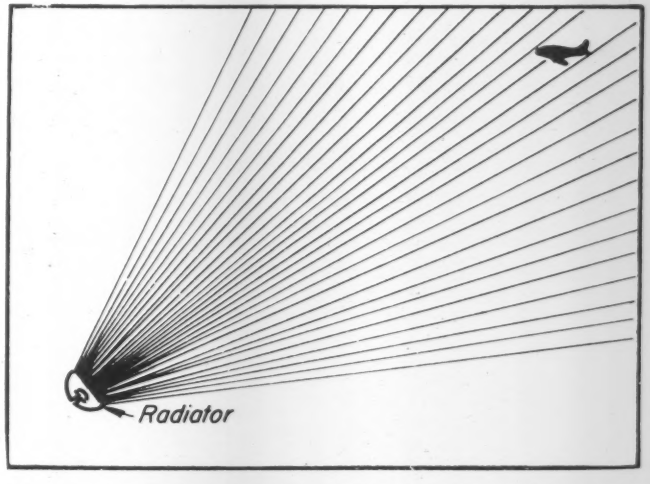
8—Time during which the transmitter sends out energy is called the "pulse duration". Number of watts delivered by the transmitter is known as the "pulse amplitude". Period of transmitter inactivity between pulses is called the "pulse interval"



9—Screen of cathode ray tube in type A indicator showing the distance-calibrated range-indicating line. "Pip" between numbers two and three is caused by signal reflected from target and indicates target is 2½ miles from detector



Range is the straight-line distance to the target, bearing is the clockwise angle the target makes with respect to a reference line fixed at the detector, and elevation is the angle a line to the target makes with a line through the detector and parallel to the surface of the earth



10—Even though radar's energy is projected into space in the form of a beam, only a portion of the energy actually strikes the target. Furthermore, what energy does strike the target is greatly reduced in strength, having thinned out in traveling from the radiator to the plane

yards away, it is necessary to have a *pulse* no longer than two microseconds and a pulse *interval* of 2,000 microseconds.

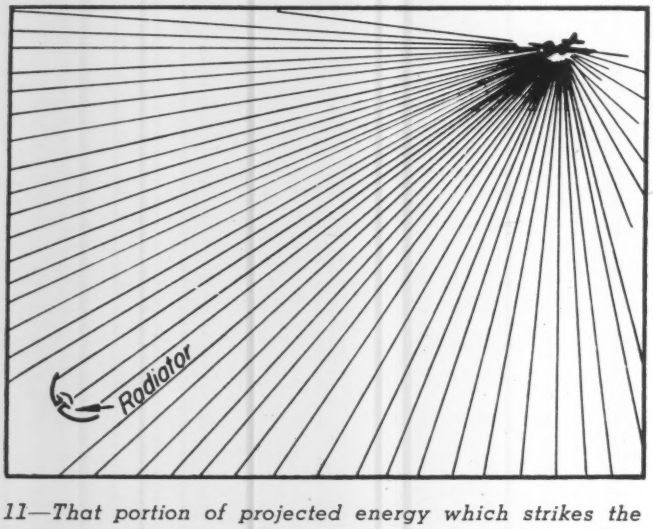
How Radar Searches for Targets: When searching for targets, radar's narrow beam of pulsed microwave energy is directed through all parts of the volume of space within which a target may lie. This process, known as "scanning", is exactly the same as seeking out a target with a searchlight. Surface scanning, employed to detect surface vessels, involves rotating the radiator continuously in the horizontal plane, usually at about one rotation in five seconds. This rate is rapid enough to insure keeping the target continually in view and it also prevents the indicating spot on the indicator screen from jerking.

How Radar Operator "Sees" the Target: What the operator sees in this type of equipment is an inverted V, or "pip", on the screen of a cathode ray tube. Impulses from the timing unit, for example, vary the voltages on the vertical deflecting plates of the cathode-ray tube to position the pip on the screen and thus indicate the range of the target. This applies to surface detection wherein the beam moves horizontally across the screen at constant speed, starting at the left when a pulse leaves the transmitter. Any pips showing along the line on the screen indicate the presence of a target and, since the line is calibrated in units of distance, the operator perceives the range immediately.

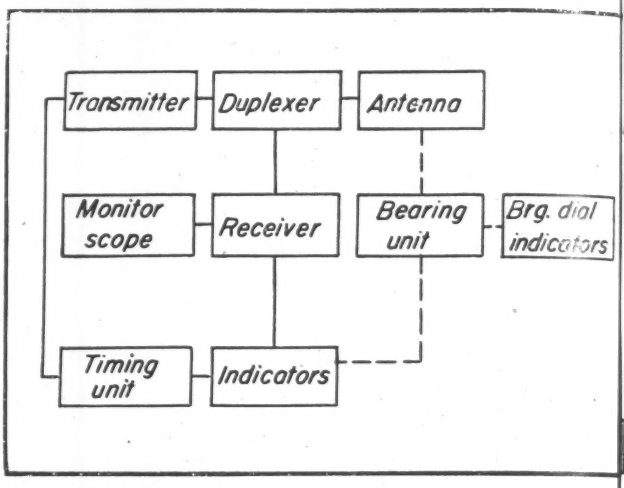
Power Required by Radar: As has been noted, the signal sent out is powerful but the reflected signal is weak. The reason for this will become apparent when it is considered that the farther the transmitted signal travels, the more thinly spread out—less dense—it becomes. For example, if four lines represent four watts of power leaving the radiator, they will pass through a one-foot square at a certain distance away where of course the density will be four watts per square foot. At twice this distance, the four lines will pass through a four-foot square where the density will be only one watt per square foot.

Furthermore, not all of the signal energy strikes the target. As with a searchlight, much of the beam passes around the target and is lost in the space beyond. The energy that does strike the target is scattered in all directions, only a small portion returning to the receiver. In addition, the reflected energy is dissipated in the same manner as is the transmitted signal as it travels back to the receiver. As far as range is concerned, doubling the transmitted power does not double the range. Actually, the transmitted power must be increased sixteen times to double the range.

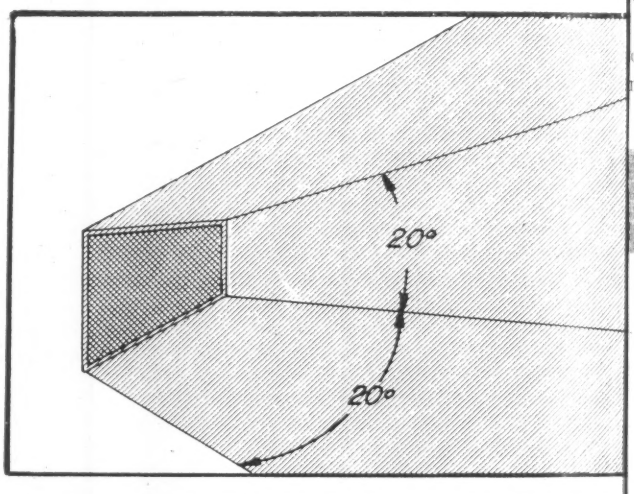
Rectangular antennas with screen surfaces also are used in radar and fulfill the same function as do the parabolic radiators. They form beams through the combined effect of the screen and the many dipoles on their surfaces. The mesh-like screen does not prevent reflection of the micro-waves because the spaces are small compared to the length of the waves. Beams from rectangular antennas have a bearing spread of about 20 degrees and an elevation spread of about 20 degrees or more.



11—That portion of projected energy which strikes the target is reflected in all directions, not in a beam. Thus only a small portion of the reflected energy enters the radiator. For these reasons, highly sensitive receivers must be used in radar



12—Components of a surface detection system shown schematically. The duplexer is a device that prevents the strong outbound signal from entering the sensitive receiver. The monitor scope has an uncalibrated screen and is used only for tuning the set



13—Rectangular antennas sometimes are used instead of the parabolic type. Like the parabolic type, they direct microwave energy into space in the form of a beam

How Stress Measurements Aid Crankshaft Design

By
S. Oldberg
and
C. Lipson
Chrysler Corp.

DUE to the complicated nature of loading, crankshaft design represents one of the most difficult problems in the field of mechanics, involving as it does consideration of lateral and torsional vibrations, crankcase rigidity, stress concentrations, etc. It is not surprising, therefore, to find some crankshafts which can sustain safely only 4000-psi nominal journal stress, while others having substantially the same dimensions operate under stresses as high as 16,000 psi. The 400 per cent difference in load capacity of the two crankhafts represents the difference between a casual approach to the problem and an approach based on a well-integrated program of design and development.

Many methods have been employed in the evolution of the crankshaft structure, some based on experience, others on a theoretical analysis, and some few on engine testing and laboratory experimentation. The choice of the method is usually based on

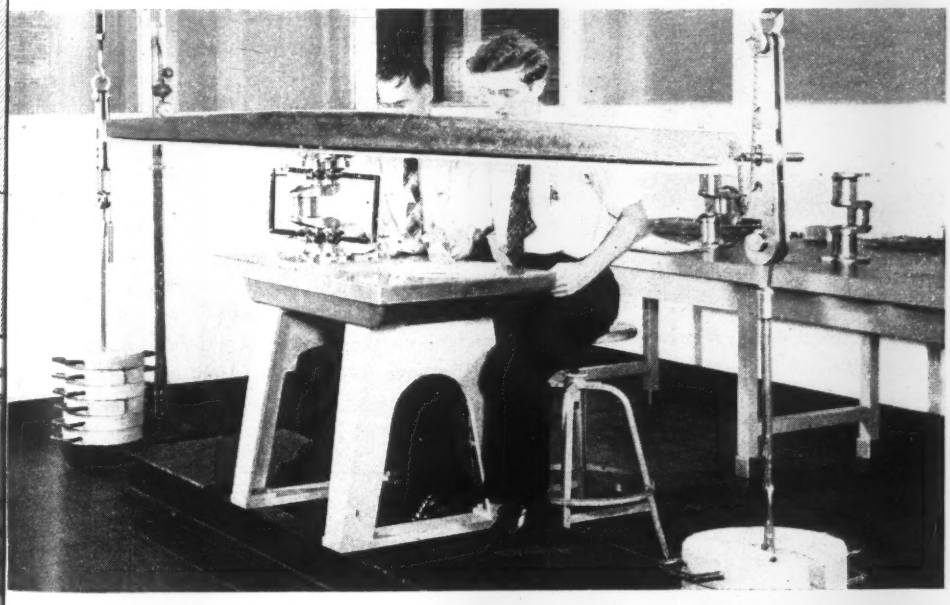
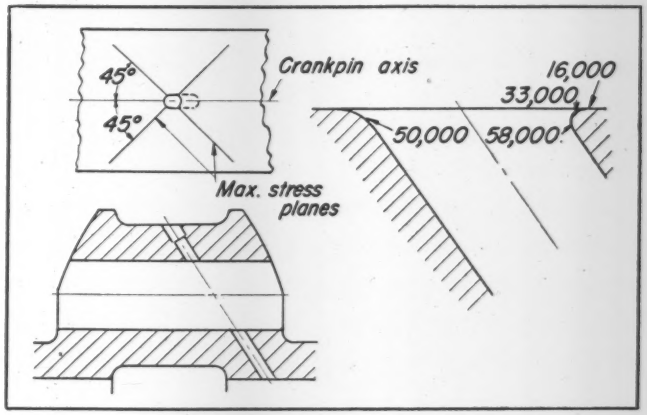


Fig. 1—Left—Set-up used in determining stresses and deflections due to bending in a single throw of a crankshaft

Fig. 2 — Below — Maximum stresses in the region of the oil hole, found by use of Stresscoat and short gage length extensometer

RATIONAL APPROACH to the design of a machine element subject to such complex loading as a crankshaft necessarily involves experience, calculation and experiment. In this article, which is based on a paper presented at a recent meeting of the Society for Experimental Stress Analysis, the authors evaluate these methods of approach and discuss some design problems that were solved through laboratory tests



available personnel, laboratory facilities and the justifiable development cost.

APPROACH BASED ON EXPERIENCE: Until recently, the development of a crankshaft was based almost exclusively on experience. This approach was effective in the case of engines having long history, provided only minor crankshaft modifications were involved. In all other cases experience was not very helpful because of the unpredictable nature of the extrapolation.

For example, a crankpin failed at the oil hole. The crankpin size was increased, resulting in a different natural torsional frequency, which corresponded to a stronger order of excitation than before and thus caused higher stresses. Again, a crank cheek was thickened because of a failure in a fillet. This resulted in a decrease of the main bearing width, which increased the effective span and thus increased the bending moment. This in turn could well outweigh the added section, particularly if a high stress concentration were present.

APPROACH BASED ON CALCULATIONS: Many uncertainties in design may be removed by mathematical analysis on the basis of which probable crankshaft performance is estimated. The procedure is somewhat as follows:

1. The basic engine design is developed to such a point that bore, stroke, mean effective pressures and speeds are known, the cylinder centers determined (by the cylinder construction), and rotating and reciprocating weights estimated
2. An indicator card is obtained at the prescribed condition from a similar engine or from published sources
3. Bearing loads are calculated and the general proportions of the journals selected
4. Natural frequencies of the crankshaft system, including all members driven by it, are calculated
5. Torque input of the throw is computed from gas plus inertia loading and a Fourier analysis of the input harmonics is made
6. Torsional deflection of the crankshaft is calculated for the entire shaft throughout the speed range. Usually several alternative firing orders are included and selection is made on this basis
7. Fillets and oil holes are designed. Stresses are calculated for combined bending and torsion, and suitable modifications are made for a more uniform stress distribution. Material and processing are selected to provide the required fatigue strength.

Theoretical calculations are invaluable in any development program and, if weight considerations are not important and a large factor of safety can be permitted, may furnish a safe procedure. However, in a mathematical evaluation of a crankshaft several uncertain values must be presumed, TABLE I. This is because the magnitude and distribution of stresses, the values of the load acting, the endurance limit of the material, and the probable effect of production variables are of necessity assumed.

If the unknowns are added up, it is evident that the straight mathematical approach must be augmented if the requirements are to be fulfilled economically.

APPROACH BASED ON LABORATORY TESTS: This leads to laboratory tests consisting of stress and fatigue measurements and calling for the study of pertinent characteristics of design, material, and manufacture. Into this category

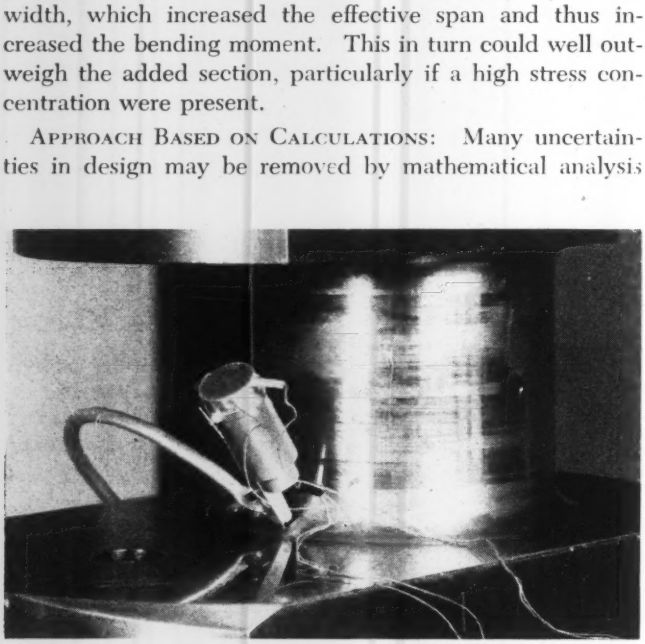


Fig. 3—Above—Application of a short gage length extensometer to the crankpin fillet

Fig. 4—Below—Traverse around crankpin fillet for determining the planes in which the maximum stresses occur

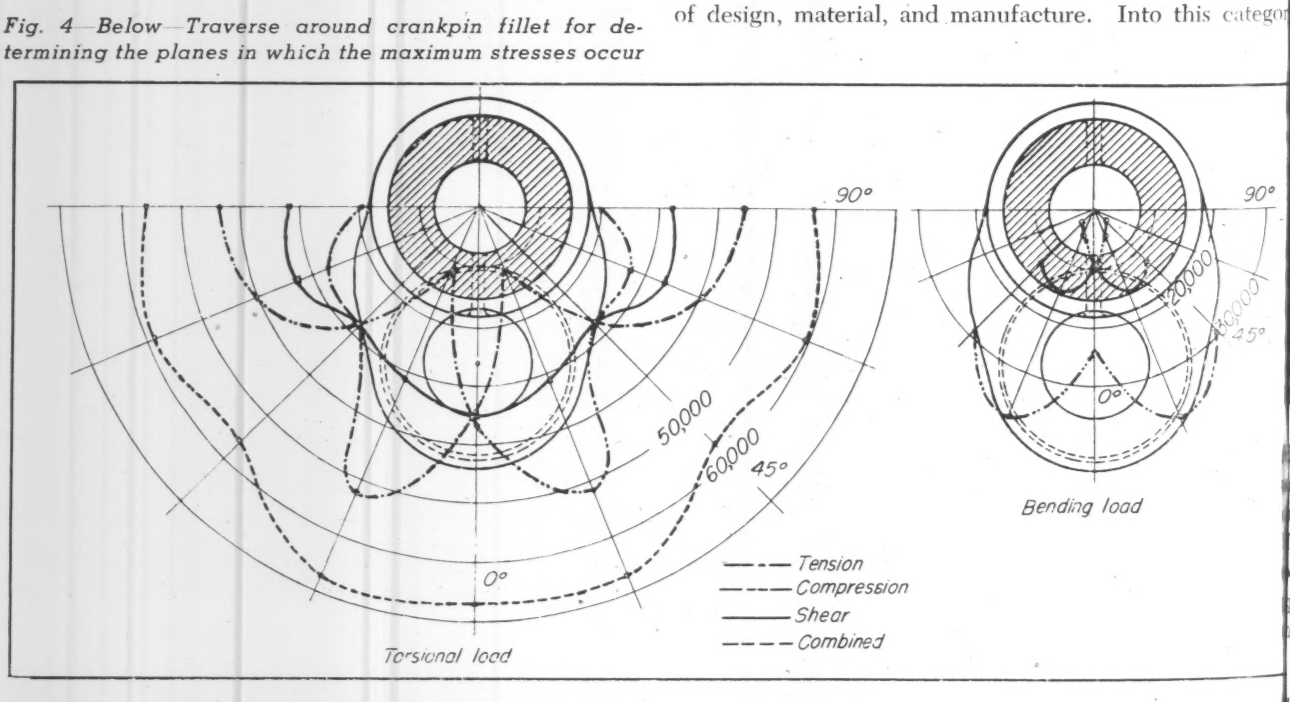


Fig. 5—Right—Stress distribution over fillets in the plane of the crank throw

all factors such as the stress concentration of oil holes and fillets, the effect of journal diameter, cheek width, lightening hole shape, surface treatment, type and heat treatment of the material, and forging and machining variables.

For this purpose a full-size single-throw crankshaft is constructed and analyzed in a loading frame for bending and torsion, *Fig.* 1. Since the critical shaft regions are the oil hole and the fillets, these two regions are investigated first in order to determine their relative stress concentrations. The oil hole is a particularly difficult region to analyze because of the sharp curvature involved and the inaccessibility to instrumentation. Stresscoat and a short gage length extensometer somewhat obviate this difficulty as indicated in the results shown in *Fig.* It will be seen that the maximum stress occurs inside the oil hole below the journal O.D. and that the stress concentration factor (58,000/16,000 = 3.6) checks quite well with the theoretical value ($K = 4$), particularly since 16,000 psi may be somewhat above the nominal stress in the journal.

Fillets are traversed by means of a short gage length extensometer as shown in *Fig.* 3. For some applications, particularly if a single-throw crankshaft is not available, photoelastic technique can be used.

Once the planes of the maximum stress are determined (*Fig.* 4), a traverse is made of the fillet itself, the resultant data for the fillet in the plane of the throw being shown in *Fig.* 5. In the application shown, stresses in the crankpin fillet were found to be equal to or greater than those in the main journal fillet. Tensile and compressive stresses due to torsion were approximately equal, thus producing pure shear as expected from theoretical considerations.

Following the completion of the stress determinations in the critical stress regions, study is then made of the remaining crankshaft sections. One such section is the crankpin cheeks whose stress distribution is shown in *Fig.* 6. Two peaks were found to exist with a low stress region in between. The small stress observed in the cheek section approximately midway between the crankpin and the main journal indicated that this section need not be any

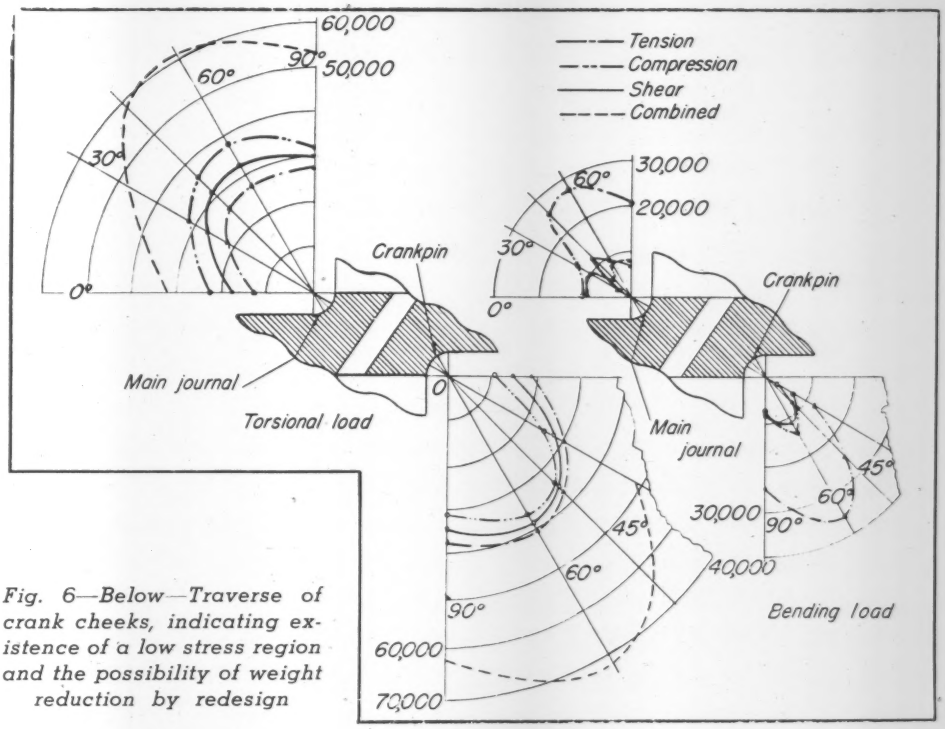


Fig. 6—Below—Traverse of crank cheeks, indicating existence of a low stress region and the possibility of weight reduction by redesign

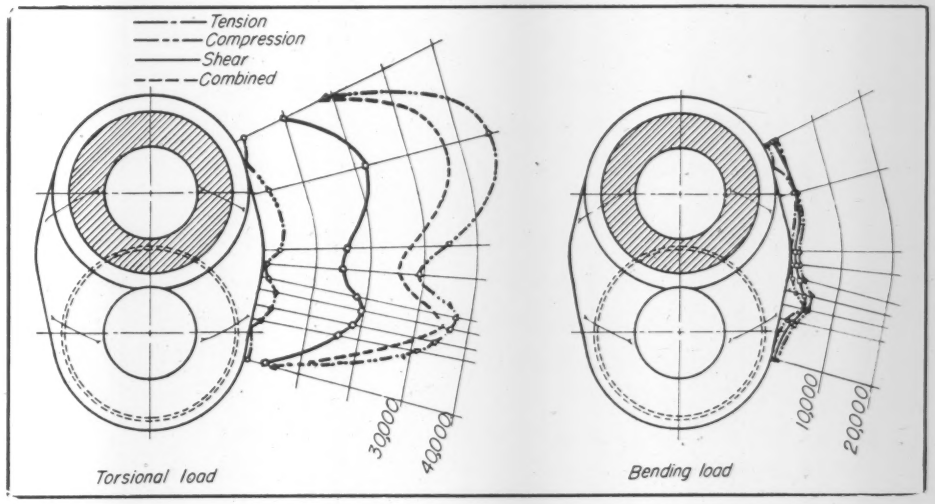
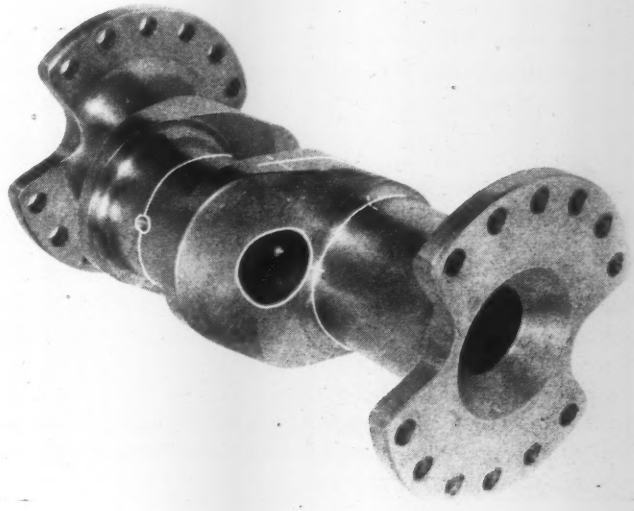


Fig. 7—Below—Complete test section of crankshaft, showing where the stress traverses were made



wider than the remaining regions and that a better stress distribution could be realized by removing metal in the low stress region. The final cheek design, of course, will be governed not only by stress considerations but even to a larger extent by rigidity requirements.

Similar stress traverses are made around the lightening hole edges so that upon completion a comprehensive stress pattern of the entire crankshaft throw is obtained. The stress traverses studied are indicated in *Fig.* 7.

Stress values by themselves will not suffice in any rational crankshaft development program and they must be accompanied by fatigue tests. The function of the fatigue tests is twofold: (1) To provide means for developing proper materials, heat treatments and fabrication processes; and (2) to check on the features of design which were evolved out of stress studies. The need for the former is self-evident. The necessity for the latter arises out of the fact that stress data do not provide an insight into the life of the part. It is thus feasible to have one design exhibiting lower stresses and yet the same life as another design, all depending upon the portion of the fatigue curve in which the crankshaft is operated in service.

Two types of fatigue testing are employed during the crankshaft development. One involves the application of reversed torsional loads, and the second reversed bending loads. Choice of the type of testing depends upon the features of the crankshaft design; if the maximum stress in the crankshaft is located at the oil hole, the principal load to consider will be torsion, and fatigue tests on sample journals will suffice. A fatigue machine for torsional loading is shown in *Fig.* 8. The journal is located between two large flywheels and the drive from the motor actuates a reciprocating connecting rod, and through it acts on a torsion spring connected to the inner flywheel. The machine operates on the sloping portion of the resonance curve of the system.

If, on the other hand, the design of the crankshaft is such that the highest stress is located at the fillet, both torsional and bending fatigue tests will be necessary. The fixture for fatigue testing in bending is shown in *Fig.* 9. It is constructed on a tuning fork principle, the source of power being obtained through an electromagnetic vibrator.

All of the previous considerations have dealt with the problems of developing a new shaft and with laboratory techniques available for their solution. The second broad range of crankshaft development problems involves the redesigning of a shaft already available. In this connection the following three specific considerations may arise:

IMPROVING CRANKSHAFT DURABILITY: The problem of improving crankshaft durability involves an increase in its output or improvement in its life. This can be accomplished by increasing overall dimensions which, however, involves a major engine redesign. By leaving overall dimensions the same and decreasing stress concentration, a more effective solution is usually obtained. Improvement in crankshaft durability may also involve changes in material, heat treatment and the fabrication method. This is occasionally a process of developing better materials and manufacturing procedures, but more often it calls for an elimination of major weaknesses discovered in engine testing, in laboratory experimentation or in service.

ELIMINATING MAJOR WEAKNESSES DISCOVERED IN SERVICE: Most of the problems which confront the laboratories involve weaknesses discovered in service operation. Major crankshaft weaknesses are crankshaft noise (particularly in automobile engineering), crankshaft failures, and failures of other engine parts which can be traced to the crankshaft.

An example of this type of problem is the redesign of a twin-cylinder engine crankshaft which had failed. The shaft had a solid main journal and a hollow cylindrical pin

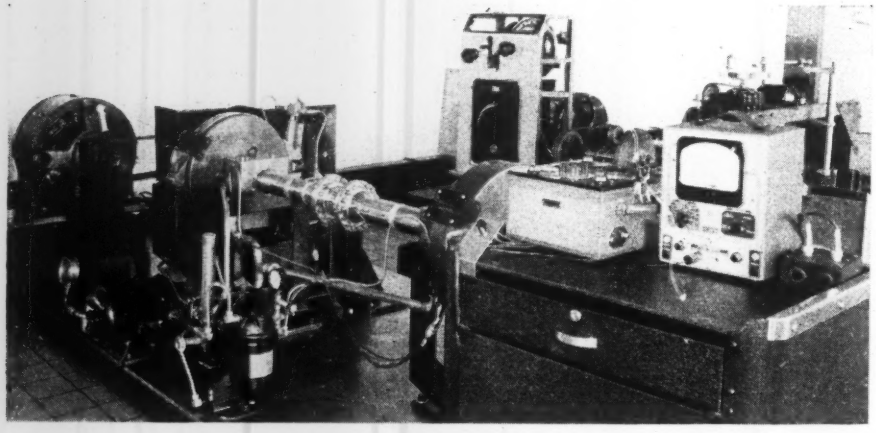
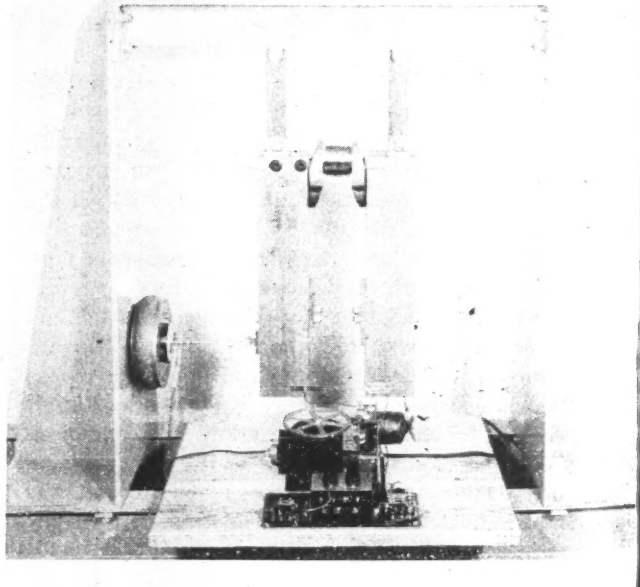


Fig. 8—Left—Testing machine for applying torsional fatigue loading to a sample journal

Fig. 9—Below—Single-throw crankshaft in fixture for bending fatigue tests. Testing device is constructed on a tuning fork principle



ilure originating at the crankpin fillet in the plane of e throw. The shaft was redesigned (see "Proposed Design No. 1", *Fig.* 10) so that both the main journal and the in were hollow. When stress analyzed it gave the results shown in TABLE II. Data given in the table show at by hollowing the main journal only a 6 per cent reuction in stress was obtained. The reason for this lies the general relationship between the fillet stresses and e lightening hole size. As the hole size is increased, the oint of maximum stress shifts away from the center (0 degrees in *Fig.* 10); the stress at this point becomes lower, nd the stress farther away along the fillet traverse becomes igher.

In the present problem, the failed crankshaft (solid ain) is characterized by the maximum stress occurring the center. In the redesigned shaft (hollow main) the aximum stress is shifted to a 22½-degree plane, leaving e stress at the center considerably lower. The two shafts pparently represent two extreme cases, and consequently

TABLE I

Uncertainties Involved in Mathematical Approach

Factor	Reason for Uncertainty	Possible Error
1. Torque—Harmonic components	Available indicator card not representative	Probably small
2. Natural torsional frequency	Participation of crankcase mass end stiffness in torsional vibration	±7 per cent
3. Dynamic magnifier at resonance	Affected by factors too complex for calculation	± 30 per cent
4. Stress concentration factors	Usually not directly calculable	± 20 per cent
5. Notch sensitivity of material in fatigue	Varies with material and section	± 10 per cent
6. Effective bending moment	Center of pressure of bearing reactions determined by deflections and lubrication	On conservative side if load is assumed to act at bearing center. Value unknown.
7. Strength of material in service	Production variables influencing fatigue strength	Dependent upon experience with manufacturing source

more favorable stress distribution should be realized m an intermediate set of dimensions. The shaft deed according to this principle (Proposed Design No. when stress analyzed, did show a definite improvent, amounting to 20 per cent.

PROBLEMS ARISING OUT OF PRODUCTION REQUIREMENTS: e following example typifies the type of problems fall under this heading. Standard American practice in plane crankshaft design involves the use of cylindrical tening holes both in the crankpin and in the main rnal. There is reason to believe, however, that a higher nkshaft strength may be realized by incorporating barshaped lightening holes. From a manufacturing point view, barrel-shaped holes involve a considerably higher

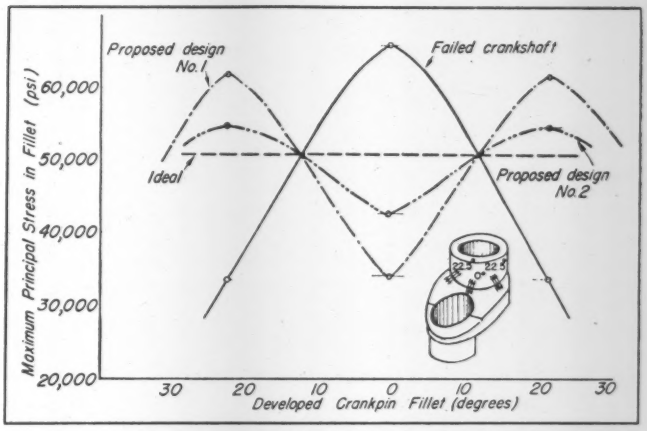


Fig. 10—Comparison of stresses in fillets of crankshafts with hollow and solid main journals

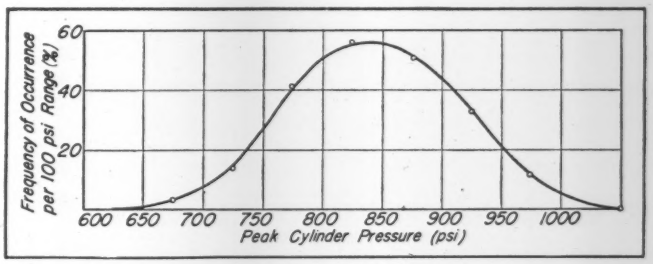


Fig. 11—Probability of occurrence of peak pressures in cylinder, based on actual measurement over 200 cycles

cost and the advantages of such a design must be real and substantial to be economically justified. Current investigation was therefore undertaken for two reasons: (1) To compare barrel and cylindrical lightening holes; and (2) in the event that the barrel-shaped hole did not offer any real advantage, to develop a cylindrical hole which would give the highest crankshaft strength per unit weight.

The tests involved a repetition of the stress measurements already described for each crankshaft design studied. Not all the stress regions or stress trajectories were repeated because it was soon verified that the design comparison could be safely limited to the study of the oil hole and fillet stresses. A review of the test data indicated that the use of barrel-shaped lightening holes resulted in lower crankshaft stresses; however, for the same unit weight and the same rigidity, less than 10 per cent reduction in stresses was realized. Whether this improvement justified the increased cost involved in the adoption of barrel-shaped holes depends on personal judgment and on circumstances.

APPROACH BASED ON ENGINE TESTS: Final judgment regarding the suitability of any crankshaft must be based on actual engine testing under service operating condi-

TABLE II

Stress Comparison for Alternative Crankshaft Designs

Design		Stress, psi	
		Plane of Throw	22½-degree Plane
Failed Crankshaft,	Solid Main Hollow Pin	66,000	34,200
Proposed Design No. 1,	Hollow Main Hollow Pin	33,400	62,000

tions. A satisfactory crankshaft must meet the dual requirements of durability and performance.

DURABILITY: In essentially all cases, a satisfactory engine crankshaft must have infinite structural life. In other words, the highest operating stress must be below the endurance limit of the shaft. Laboratory fatigue tests have proved that successful completion of 10 million stress reversal cycles normally insures infinite life at the load applied. Thus one hundred hours of engine operation at maximum crankshaft stress conditions (if speed exceeds 3300 rpm) would be expected to be sufficient to insure freedom from service failures. It is a somewhat disconcerting fact that this is not the case and that failure due to bending loads may occur after several hundred hours of maximum output operation.

This is true because bending loads are a function of peak cylinder pressures, which vary greatly from cycle to cycle even though the engine output is constant. This phenomenon is illustrated by *Fig.* 11, which is a probability curve based on the direct measurement of 200 successive cycles in an aircraft engine cylinder. Thus once every fifty or so revolutions the turbulence conditions in the combustion chamber may be such as to produce a particularly high peak pressure and a resulting high crankshaft bending stress. Unless this abnormal stress is below the endurance limit, breakage will eventually occur.

PERFORMANCE: Satisfactory crankshaft performance in engine installation involves freedom from objectionable noise and vibration, adequate journal wear, and good performance of related parts. Bending deflections which move the flywheel and thus displace the entire engine as a reaction, as well as torsional vibration periods, produce noises which may be beyond acceptable limits, particularly in automotive applications. A structurally sound crankshaft may, therefore, require further development to eliminate this objection. Abrasives in the lubricating oil under service conditions producing abnormal wear may influence the selection of journal material or processing. It may frequently happen that a proposed crankshaft operates satisfactorily except that it adversely affects the life of related engine parts. For example, torsional periods not harmful to the shaft may be destructive to gears and other parts driven by the crankshaft. The inertia forces of the shaft may impose bending moments on the crankcase which cause failure. Localized crankpin deflections and the geometry of the oil holes may adversely affect bearing performance.

In addition to providing the final check of a crankshaft application, engine tests are essential to the interpretation, refinement, and extension of both the analytical and experimental laboratory studies. In the first place, engine test data provide means of measuring some of the unknown and assumed quantities encountered in the analytical and laboratory studies. Thus, torsional vibration measurements may be made to determine the torsional natural frequency of the shaft, and its torsional amplitude at various operating conditions. *Fig.* 12 illustrates the results obtained from a typical test. The natural frequency of the shaft can be readily calculated from any of the six resonant points shown. The amplitude of the resonant peaks indicates the relative magnitude of each of the torsional vibratory orders (multiples of engine rpm).

Using Strain Gages on Engine Tests

Stress measurements of the crankshaft during actual operation may be made by the use of wire strain gages, with leads brought out through slip rings at the end of the shaft, recording the output on an oscillograph. Gage positions necessarily are limited to lightening-hole and cheek surfaces. Analysis of these records reveals the predominant type of loading, the presence of resonant conditions and the effects of engine operating conditions. Quantitative results may be obtained by stress measurement of maximum stresses in critical areas under static loading which reproduces the engine test gage readings.

This procedure is of particular value in locating unsuspected loads, such as resonant axial vibration in the engine throws. Examination of a failed crankshaft often reveals both the origin of failure (point of highest stress) and the type of loading. Thus these two highly important factors are definitely ascertained.

Knowledge gained by well-instrumented engine testing gives the analyst definite facts enabling him to refine his design calculations toward a better balanced design in the engine under development as well as to provide further basic data to guide new designs. Laboratory data can be re-interpreted in the light of the more accurate loading conditions determined by engine tests. Knowledge of these loads also allows the laboratory to extend their studies to determine modifications which will produce a more uniform stress level in the shaft under the engine loading condition. In particular, investigations to reduce the stresses at points of failure will be conducted.

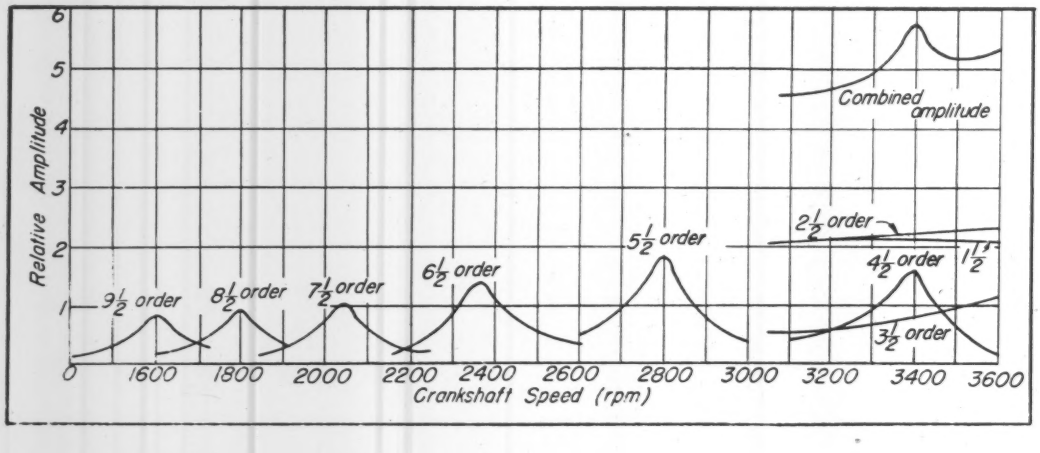


Fig. 12—Left—Relative torsional vibration amplitudes. Natural frequency of shaft can be calculated from any of the resonant points

How To Protect Machine Improvements

By George V. Woodling

ALTHOUGH an improvement in a localized part of a machine may represent a large amount of creative and development work, the patent covering it may be so ineffective as to be unable to protect the improvement. One reason is that it is difficult from the engineering point of view to ascertain whether the localized improvement is such as to affect the entire operation of the machine, or whether its function resides solely within itself. The determination of this engineering question is of paramount importance to the prosecution of the patent application.

All too frequently the decision is left to the patent department or patent attorney. Failure to consult the engineering department or the machine designer is detrimental to obtaining good patent protection, inasmuch as these questions and the way in which they dovetail with patent procedure call for both legal and engineering knowledge. The absence of cooperation sometimes results from a feeling on the part of engineers that, since they are unfamiliar with patent law, their help is of little value to the attorney. This article is written to give the machine designer the necessary working knowledge of that particular phase of patent law dealing with the problem of protecting localized improvements, so that he may with greater confidence advise the patent attorney on such questions.

Presentation of the problem may be simple illustrated by assuming that the entire machine has five essential parts: *A*, *B*, *C*, *D*, and *E*. The designer makes an improvement in the part *E*. If the function of the part *E* is localized, the designer has made but one invention. On the other hand, should the improvement in the part *E* be of such a character as to modify the operation of the parts *A*, *B*, *C*, and *D*, then the designer has, in fact, made two inventions: (1) In the entire combination of the new machine, and (2) in the localized part *E*.

To protect these two inventions, two sets of claims are required. One set—known as combination claims—would be directed to the combination of the entire machine. The other set—referred to as subcombination claims—would be directed to the localized improvement. In cases where the improvement

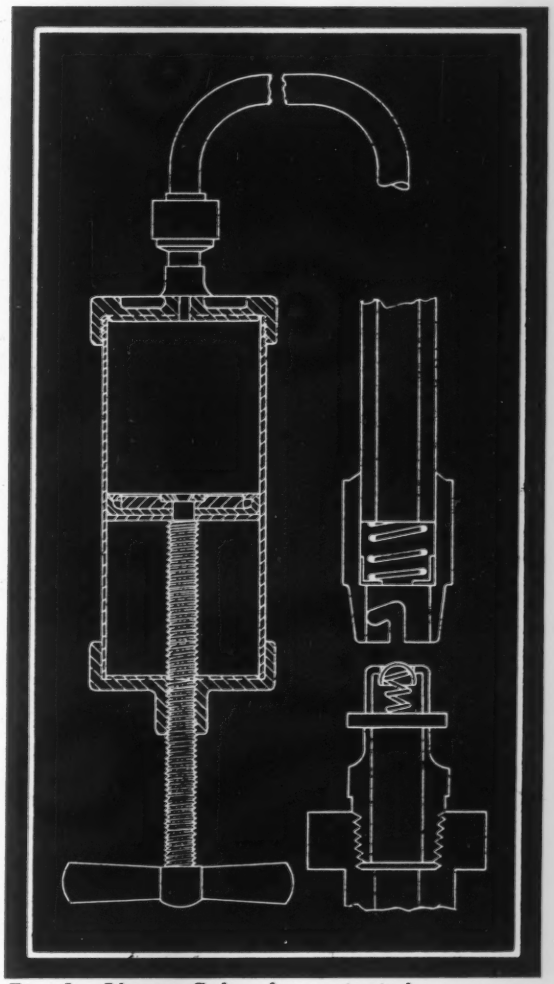
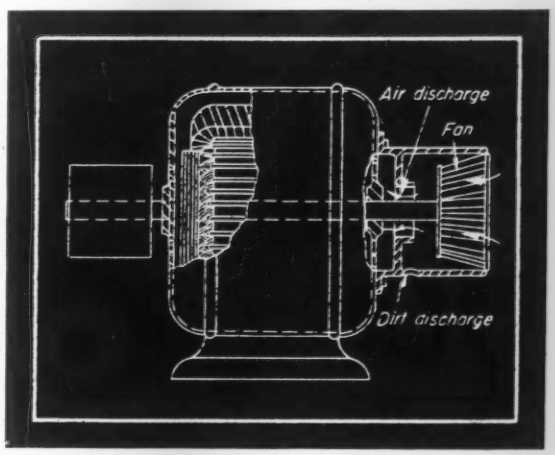


Fig. 1—Above—Sale of unpatented grease gun for use with patented cross-pin type of fitting was charged to be contributory infringement. Outcome of suit hinged upon fact that improved fitting did not affect the operation of the gun

Fig. 2—Below—The Patent office rejected combination claims for the electrical machinery ventilating equipment shown, in which dust separation is effected by inertia, and cited the prior patent illustrated in Fig. 3



resides solely in the part *E*, it is important that the patent contain at least subcombination claims, because combination claims are ineffective to protect a purely localized invention. Should the patent claims for a localized invention be improperly directed to the entire combination instead of to the localized part, the entire patent may be held invalid.

The practical aspects of the foregoing principles of patent law may be illustrated further by reviewing a Supreme Court decision involving the grease gun shown in *Fig.* 1, which is used in lubricating bearings, particularly those for automobiles. Tubular grease fittings have projecting pins or lugs on opposite sides to be engaged by a bayonet coupler having a hooked slot for making a good connection while grease is being forced into the bearing. Novelty of the tubular fitting shown in *Fig.* 1 lay in the idea of a pin which ran directly across the tube and extended out on both sides, instead of short pins or lugs set in on either side. The portion of the pin which bisected the tube was used as a base for a spring to hold in place a ball valve which closed the opening of the fitting. No other fitting employed the cross pin both to form the lugs and to constitute the base for the spring. It should be noted that the entire assembly comprises (1) a tubular cross-pin type of fitting, (2) a detachable bayonet coupler, (3) a hose, and (4) a grease pump. The patent in the suit was directed toward the combination of the four elements mentioned. One of the combination claims in the suit reads as follows:

> "The combination with a grease cup comprising a *tubular member* having a closure seat, a closure, a pin extending through said tubular member and from both sides thereof, and a spring confined between said pin and closure, and tending to hold said closure on its seat, of a *grease pump* having a discharge conduit, and *means* (detachable coupler) co-acting with the ends of said pin for detachably connecting the discharge end of said conduit with said grease cup."

In this claim it is noted that the tubular member is limited to the type having a cross pin for supporting the spring. No limitation is imposed on the grease pump, the hose, or the detachable coupler, which thus may be of any type.

Issue of the suit involved the sale of the defendant's grease gun, which was old and unpatented. The sale was charged to be "contributory infringement" of the patent which included the foregoing combination claim, among others. A contributory infringer is one who manufactures one or more *un*patented parts of a patent combination and sells it to a direct infringer, with the intention of aiding and abetting him. The direct infringer, in this case, was the service station operator. The instant an operator connected the coupler of the defendant's grease gun to a car having the plaintiff's cross-pin type of fittings and used the gun, he committed an act of direct infringement inasmuch as he was using all of the elements set forth in the combination claims. The owner of the combination patent contended that, notwithstanding the fact that the grease gun was old and unpatented, the sale of it by the defendant contributed to the infringement of the combination claims.

Patent Claimed More Than Inventor Invented

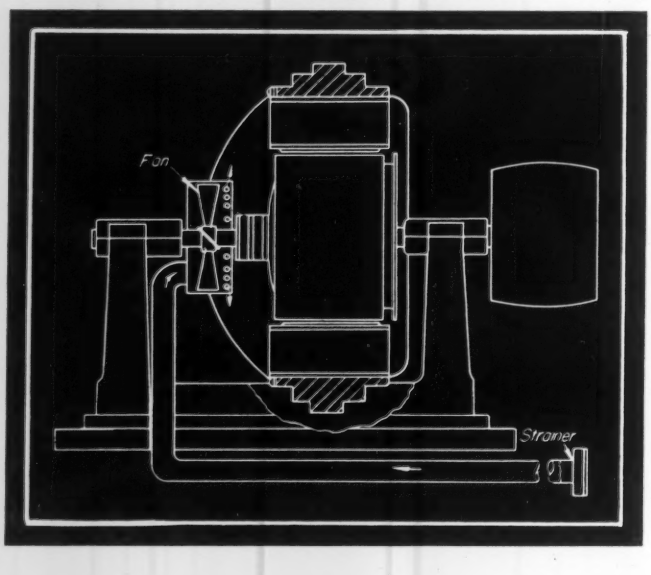
The District Court held the defendant liable for contributory infringement and the Circuit Court of Appeals affirmed the decision, but the Supreme Court reversed the decisions. The Supreme Court in its examination of the case inquired as to whether the new cross-pin type fitting influenced the operation of the pump; that is, whether a new result was produced. Upon failure of the patent owner to show any new result of mutual cooperation between the pump and the fitting, the Court concluded that the patent was void as claiming more than the inventor had invented. Inasmuch as the inventor was not the first to invent the entire combination, it was old or "exhausted."

An example of an improvement in a localized part which coacted with other parts of the combination to produce a new patentable result is found in the ventilating apparatus for the electric generator shown in *Fig.* 2. The machine comprises a rotor, a stator, and a casing enclosing the rotor and stator. A ventilating housing is secured to the casing and surrounds a portion of the shaft, which projects through one end. The ventilating housing adjacent to the casing has an air discharge opening surrounding the shaft and communicating with the rotor. Air motivated by a fan on the shaft is caused to travel through the housing in a helical path, which by inertia throws the dust particles out of the ventilating housing through a dirt discharge port in the side wall.

In the prosecution of the patent application before the patent office, the inventor presented several combination claims which the patent office rejected as drawn to an exhausted combination in view of a prior patent shown in *Fig.* 3. This device, as can be seen, describes a system in which the machine has a shaft-mounted ventilating fan that draws air from an inlet pipe through an opening provided in the fan housing. The air is strained through a gauze strainer before it reaches the fan. One of the rejected claims for the design shown in *Fig.* 2, which appears representative, reads as follows:

> "The combination, with an electric machine which

Fig. 3—Because the gauze strainer which removes dust in this design of ventilating equipment is not dependent on operation of generator or fan, the court allowed combination claims for subsequent patent shown in Fig. 2



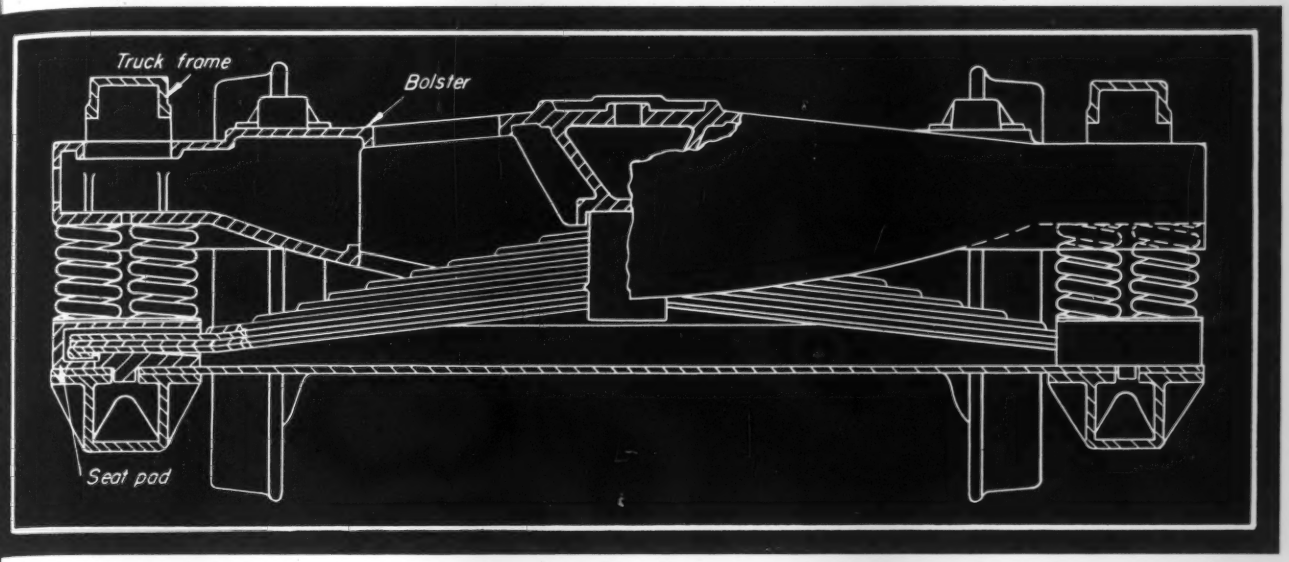
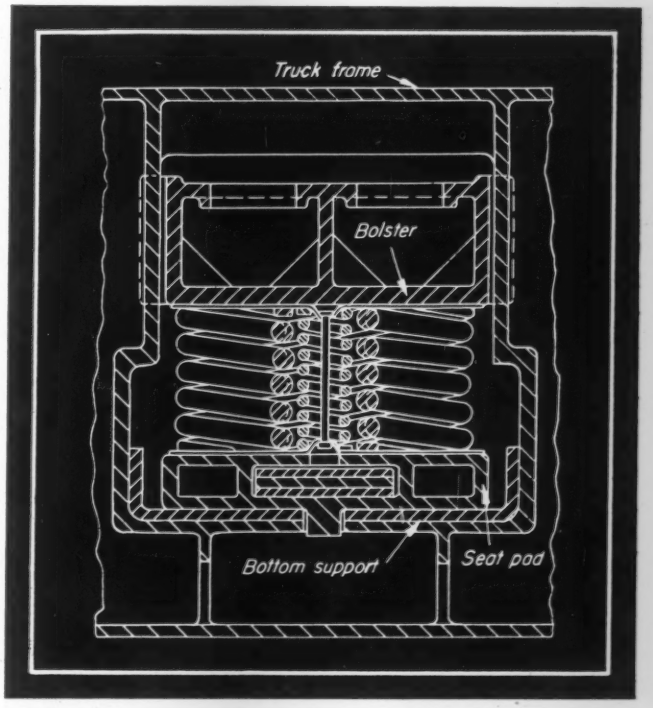


Fig. 4—Above—Railroad car truck construction for which both combination and subcombination claims may be made

Fig. 5—Below—Sectional view showing detail of seat pad members of Fig. 4 and how they and the semi-elliptical spring are incorporated in the design of the truck



> includes a rotor, a stator, and a casing enclosing the rotor and stator, of means associated with the rotor to effect an *inertia separation* of foreign matter from air and to circulate the cleaned air over the machine so as to cool the working parts thereof."

It will be seen from analysis of this claim that the inventor attempted to claim an electrical machine with means for performing two functions: (1) Inertia separation of foreign matter from air, and (2) circulation of the air thus cleaned over the machine for cooling purposes. The patent office contended that if the inventor had made a patentable contribution it would reside in the specific construction of his ventilating apparatus by itself and not in the combination of the blower with the electric machine.

Air Cleaning Depended on Motor Operation

The patent office finally rejected the claims and the inventor filed an appeal to contest this action. The court reversed the decision of the patent office and allowed the inventor to obtain combination claims directed to both the machine and the ventilating apparatus. In the inventor's device, *Fig.* 2, the court found that cleaning of the air, as well as its circulation after being cleaned, is wholly dependent upon the operation of the motor which in turn operates the fan, while in the apparatus shown in the prior patent, *Fig.* 3, the gauze strainer is in no way dependent upon the operation of either the generator or fan insofar as actual cleaning of the air is concerned.

The question may now be asked, "Why seek to obtain combination claims when subcombination claims may be obtained?" The answer is that combination claims extend the area of protection beyond that afforded by subcombination claims. In combination claims, the localized improved part need not be claimed so specifically as in subcombination claims, with the result that it may be more difficult for competitor to design around combination claims. Note that the foregoing ventilating claim covers an electrical machine with any type of ventilator employing *inertia separation*. The claim does not set forth the physical construction of the ventilator, but only specifies inertia separation. In a subcombination claim the inventor is required to set forth more detail such as illustrated by the following example:

> Ventilating apparatus comprising a housing having in one end thereof a reduced air discharge opening and a collar surrounding the opening and projecting into the housing, air propelling means in the housing to cause air to travel through the housing in a helical path, and a dirt discharge port in the side of the housing.

This claim may be designed around by omitting, for example, the collar surrounding the opening, or by relocating the air discharge opening on the side of the housing.

At this point it may be well to explain what elements of

a claim constitute the real body of the claim as distinguished from the preliminary clause or introductory part of the claim which establishes the "setting" or "environment" of the localized invention. This may be explained by assuming that one invents a new type of wheel. A wheel must be used on an axle, but the axle is no part of the invention. In drafting the claim the question arises as to how the axle may be set forth in the claim without making the axle any part of the claim. If the claim is written as follows, the axle becomes a positive part of the claim:

> A wheel comprising, in combination, an axle, a hub to rotate about the axle, a rim, etc. . . .

Such a claim would be held invalid as claiming more than that which was invented. Improvement in the wheel does not give the inventor the right to claim the axle. The claim may be correctly written by mentioning the axle in the introductory clause. The claim may now read:

> A wheel adapted to rotate about an axle, said wheel comprising, in combination, a hub to rotate about the axle, a rim, etc. . . .

Here the word axle in the introductory clause is not a positive element of the claim, but merely constitutes the environment of the localized invention.

Distinction between subcombination and combination claims may be further illustrated by referring to *Figs.* 4 and 5 which illustrate a car truck construction for a rail vehicle. The novelty of this car truck construction resides in the large semi-elliptical spring and the seat pad members which support the ends of the semi-elliptical spring as well as the coil springs. Seat pad members are carried by the bottom support of the truck frame and are mounted in the side opening or window of the truck frame, directly below the ends of the bolster. The ends of the large spring rest upon a convex support block and are provided with a stop which fits within a stepped recess to prevent accidental withdrawing. This invention is particularly designed to afford a soft spring cushioning effect which will absorb the vertical shocks. A subcombination claim may read as follows:

> In a spring construction for car trucks having side frames with openings therethrough, a bolster having its ends projected into and guided by the side walls of said openings and coiled bolster springs disposed below the bolster ends and carried by the side frames, *the combination of* a semi-elliptical spring construction made up of a plurality of leaves secured together and seat pad members constituting seats for the coiled bolster springs and for the ends of said semi-elliptical spring constructions, the said seat pad members each having a convex support block for supporting the ends of said spring construction, said support block having a stepped recess with a side shoulder, and stop means on the ends of the spring for preventing accidental withdrawing of the spring ends from said recesses.

Here it will be noted that the preliminary clause prior to the words "the combination of" is not made a positive part of the claim and accordingly such a claim would not be held invalid because here the inventor is claiming only the semi-elliptical spring construction and the details of the seat pad members

The Supreme Court has held that the mentioning of other parts in the preliminary clause does not render the claim invalid as claiming more than the subcombination. The language of the Supreme Court reads as follows:

> "Such preliminary statement is commonly and properly used to specify the type of machine in which the claimed subsidiary combination of elements works an improvement over the prior art. . . . In mentioning other mechanical parts, the claim does not purport to embody them as elements of the claimed combination. To construe such a claim for a combination of new elements intended to be embodied in some well-recognized mechanical aggregation, such as a sewing machine or a washing machine, as a claim covering all the mechanical details, or all the well-known parts of the machine, would be to nullify every patent for an improvement in a type of machine long in use and would invalidate thousands of patents for improvements in standard machines."

It can be sincerely contended by engineers that the car truck presents a design in which the localized improvement affects the entire combination. The following claim may be typical of a combination claim:

> In a car construction of the kind described and *in combination,* a pair of truck side frames, each having an opening, a seat pad member fitting in said openings with a coil spring carried by said seat pad members, a truck bolster having its ends extended into and guided by the side walls of said openings and carried by said coil springs, and means (large semi-elliptical spring) connecting said truck seat pad members and yieldingly supporting the bolster intermediate the ends thereof.

All that part of the claim which follows the words "in combination" constitutes the real body of the claim. In order to support the validity of this claim, in case it should become involved in a suit, the inventor will be required to show that the function of the elliptical spring and the seat pad members modify the action of the truck frames, the coil springs, and the bolster.

With both subcombination claims and combination claims in a patent, the inventor has obtained the maximum degree of protection. Should the subcombination claims be designed around by competitors, the inventor can fall back on the combination claims to enjoin the competitors from making the infringing device. In the prosecution of the patent, should the engineer feel that there is a doubt as to whether or not the localized improvement affects the entire machine, he should nevertheless present combination claims in addition to the subcombination claims. In this manner, he will be able to obtain his full protection.

MEMBERS of the Integral Horsepower Electric Motor Industry Advisory Committee believe that their industry is in an excellent position to meet demands for motors required for resumption of civilian production as soon as manpower and materials become available. Only a minimum of retooling will be necessary for reconversion to peacetime programs.

Fig. 1—Functions of plastic molding press are controlled by a timer. Auxiliary timer facilitates changing time of cure without disturbing settings in the master control

Selecting Timers for Automatic Control

Part II
Program Timers

By John W. Greve
Associate Editor

PROGRAM TIMERS for machine control involve intervals of timing up to an hour or more and may have many independent circuits related to each other only with respect to time. Such timers are motor driven, usually synchronous or subsynchronous, and employ cams or a drum with adjustable limits to close and open a pilot circuit for the power circuit for machine operation. Any number of circuits up to eight or more with time cycles ranging from fractional parts of a minute up to any length desired are available as standard equipment. In fact astronomical timers provide different programs for each day of the year and may repeat without resetting from year to year except leap year. The additional day is incorporated by manual resetting.

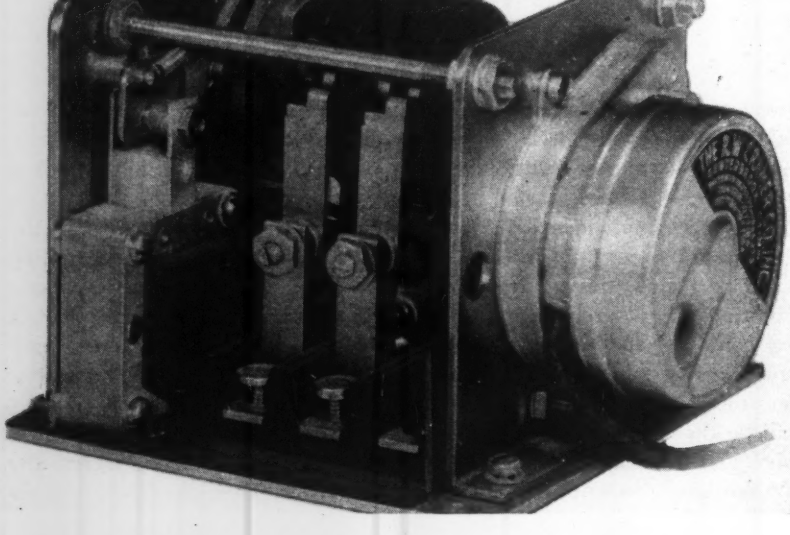
Accuracy of a timer is dependent upon the drive motor characteristics, length of time cycle, drag effect of contact operation, and type of cam or switch mechanism employed. Usually, units are sufficiently overpowered to discount the drag effect. Type of cam employed will be discussed later. For a given type of timer, accuracy varies inversely as the length of the cycle employed. When desired to have accuracy beyond the limits of a timer on long cycles, it is possible to employ two timers in series—one master control slightly beyond the desired limits and a second, faster operating control for the precise operation but incapable of maintaining the program during the length of interval required. Another method for controlling a precise time function in a program is an arrangement whereby the master control switches in a secondary control and remains inactive until the more accurate timer completes its operation. At that time the master control is again energized to complete its program.

No more accuracy need be provided in a program control than necessary. For example, laundry machines generally do not require a high degree of precision. Their circuits

vary from simple controls for reversing the tubs to somewhat more elaborate timers for water changes, additions of soaps, etc. Often such timers are driven by induction motors or shaded-pole motors where synchronous speed is not essential. At the other extreme, many chemical processes like production of synthetic rubber necessitate accurate control for the many automatically timed steps in production. Temperatures, pressures, flow rates, pH, and liquid levels not only must be regulated according to fixed schedules but also must be co-ordinated with the timing of various mechanical operations such as the opening and closing of valves and starting and stopping motors.

Automatic plastic molding presses such as shown in *Fig.* 1 are another type of equipment necessitating accurate time control. Involved in this press are sequence timing for closing, applying booster pressure, bumping, molding

Fig. 2—Above—Timer developed for domestic equipment. Pins that are pulled indicate time-on periods in this unit



period, and opening. An auxiliary timer is incorporated to provide for variations in the curing operation without affecting the timing of the rest of the program. The time motor stops during the period that the auxiliary timing mechanism is operating.

When each interval of operation varies in a machine but may be preset, the timer illustrated in *Fig.* 2 has interesting possibilities. Announced recently by General Electric Co. and Warren Telechron Co., it is especially designed for domestic equipment such as ranges and radios. Utilizing a twelve-hour synchronous clock, the timer is divided into 15-minute periods with corresponding pins around the dial. By pulling any pin, consecutive pins or series of pins the timer may be preset for operation during any period or number of periods in 12 hours. It automatically resets so the cycle will not repeat. Simplicity of the control and visual indication of a program make this timer easy to use.

In *Fig.* 3 is shown a typical cam-operated timer. This particular unit has two circuits but its shaft and cams may be extended to include eight circuits or more when the torque of the driving motor is correspondingly increased. Timing cycle of this unit, designed by the R. W. Cramer Co., is between 6 seconds and 5 hours, depending on the gear reduction and motor speed.

Momentary energization of the solenoid in the left foreground starts the timer. It will stop after the cycle is complete. Cams are mounted in pairs so that on and off increments can be adjusted on each circuit, either 0.3 per cent to 26 per cent or 2 per cent to 49 per cent of the total cycle. Contact arm action on the cams is designed for quick make and break.

Timer Motors Have Wide Range

Timer motors built by Haydon Manufacturing Co. have output speeds ranging from one revolution in 1000 hours up to 300 rpm, developing 5 inch-ounces of torque at one revolution per minute. They can be supplied with double, triple and quadruple field construction to develop 2, 3 and 4 times, respectively, the torque of a single motor. Timers built by this company have adjustable cams for one on and one off impulse per revolution or special cams to give varied operation per revolution.

Any number of switches from 1 to 8 are available in a single timer for multiple circuits. For automatic resetting by a spring one style of timer disconnects the gear train when the motor is de-energized, allowing a small spring force to return the cams to the starting point. The timers are supplied with single-pole double-throw switches rated at 10 amps, 125 volts. Thus the switches may be used also as normally open or normally-closed. The Haydon Company also builds direct-current timing motors that have stable speeds ranging from one revolution in 96 hours up to 900 rpm at 6 to 30 volts.

Fig. 3—Left—Small timing motor drives this two-circuit adjustable cam timer.

Some timers have provision for gear changes to vary the cycle time. Such a timer, built by National Time & Signal Corp., is shown in *Fig.* 4. Seventy speeds from one revolution in 2½ days up to 457 rpm are available.

Percentage on-off time depends on the type of cam utilized. Shutter cams can be fanned to regulate the time a circuit is closed from 0 to 90 degrees and by reversing the contact members from 270 to 360 degrees. Ordinary notched cams simply initiate the external circuit, closing it momentarily or, by reversing the contact member, opening it. A third type of cam is a 180-degree fan cam which will permit opening the low portion to a full 180 degrees. The most accurate cam arrangement is the double cam per circuit using two rocker arms with contacts in series. The circuit is closed by the first rocker arm dropping, and opened when the second arm drops to break. With this arrangement small intervals of "on" time may be obtained even though cam rotation is very slow.

Another type of timer, shown in *Fig.* 5, utilizes a drum with dovetail grooves and adjustable pins. Two pins are associated with each circuit, one long and one short. With the use of a latch mechanism, opened and closed by the two pins, one switch only is needed for each circuit. These may be either pneumatic valves or electric switches. In the Taylor timer illustrated, six latches operate five air valves and one mercury switch. The cycle is initiated by a latch-trip solenoid mechanism and a mercury switch at the right of the six switches. By positioning the lower dial which is associated with a variable dog-and-latch mechanism, 78 different drum speeds may be selected from each gear ratio.

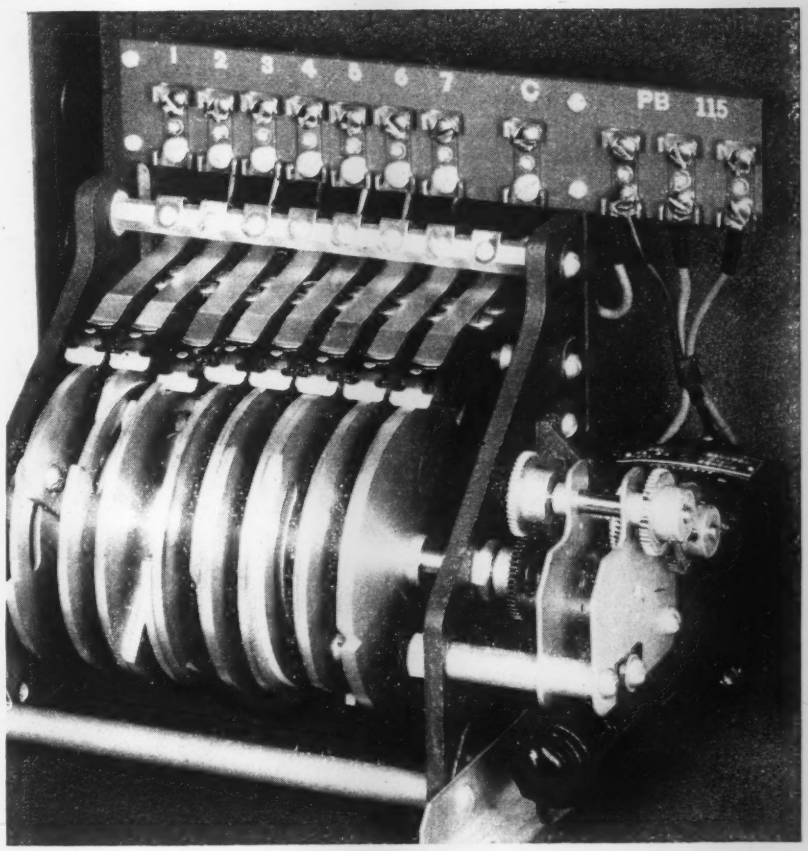
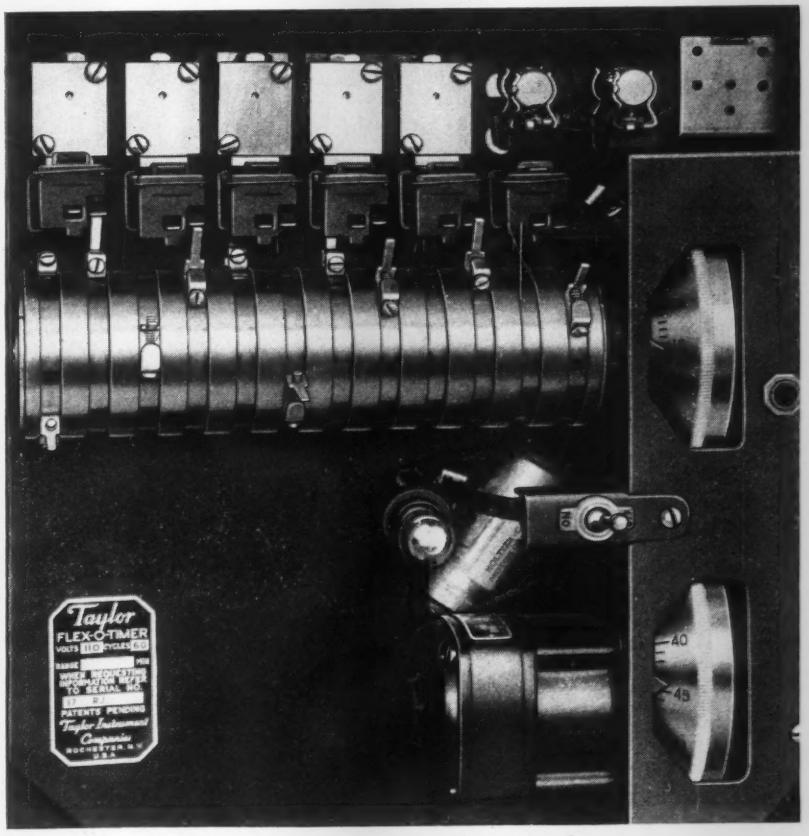


Fig. 4—Above—Multicircuit adjustable-cam timer provides for cycling time over a wide range through 70 gear-changes

Fig. 5—Below—Adjustable speed for cycling time is obtained by setting of lower dial to adjust a dog-and-latch mechanism. Drum has two adjustable fingers for on-and-off operation of each switch latch



No Load on Timing Motor

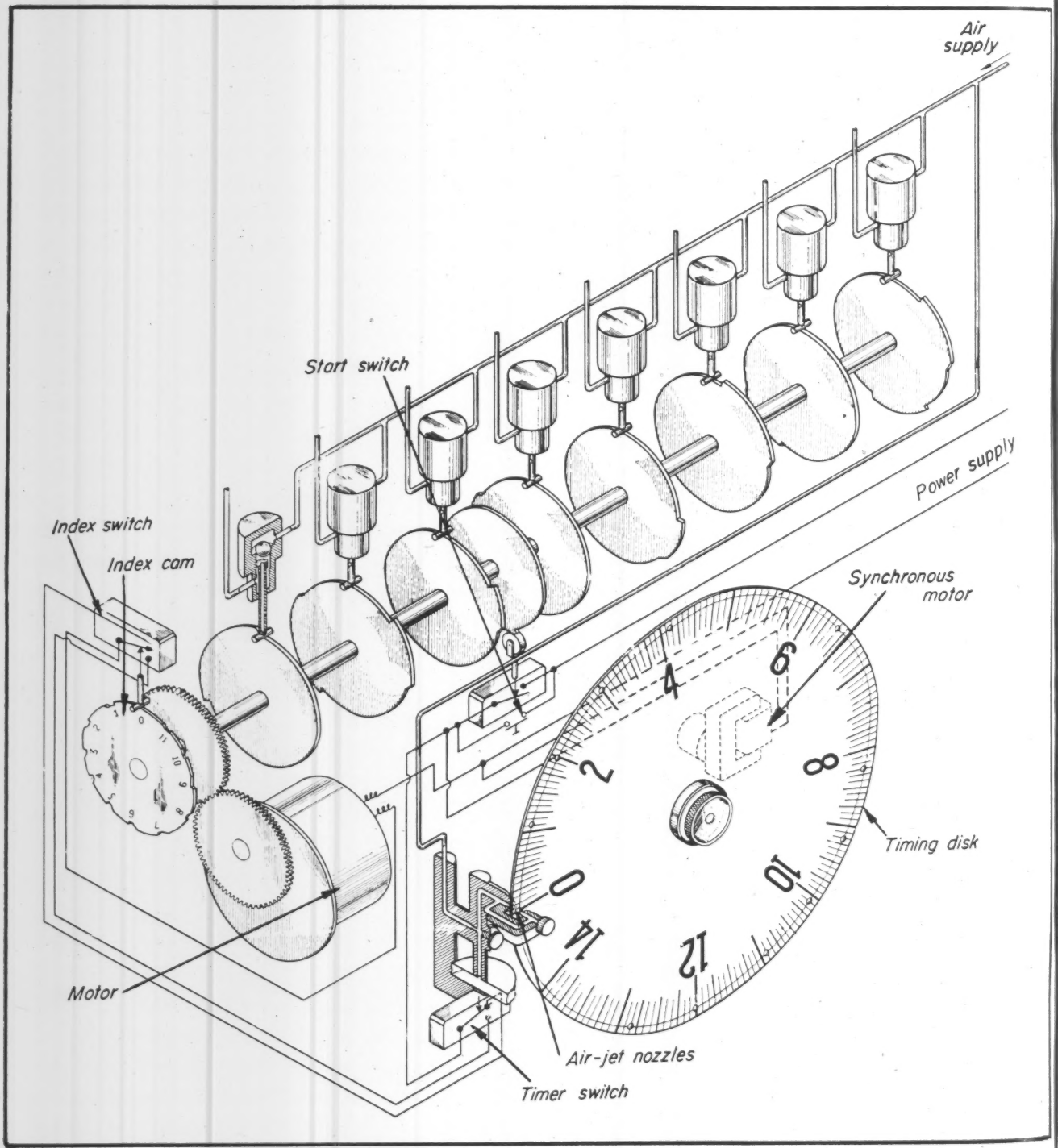
For timing operations where accuracy must be maintained, timers have been developed so that no switching load is imposed on the timing motor. Such a control is the Bristol timer illustrated schematically in *Fig.* 6. The timing disk is driven by a small synchronous motor and has a scale 25 inches long with perforations for cycle control. After the timing cycle is initiated a cam follower closes a switch in parallel with the starting switch to maintain the circuit to the timing motor. When a perforation is between the jet nozzles, reduced air pressure closes the contacts of a timing switch. With the start and index switches closed, a drive motor turns the cams until the follower of an air-index cam drops into a recess and opens the motor circuit. This repeats for

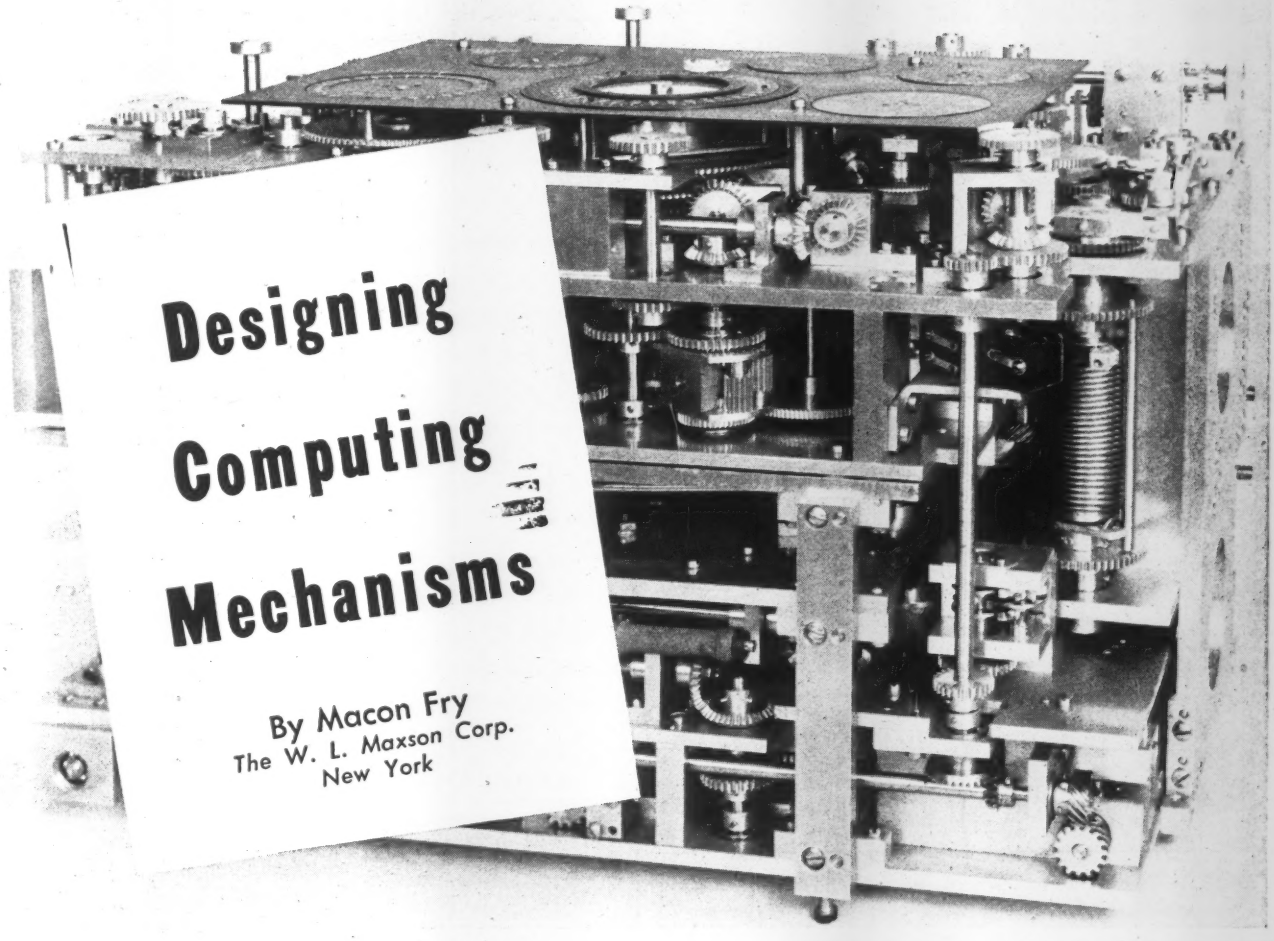
each interval punched on the timing disk, the pilot valves being operated by their cams in the desired intervals.

Rotation of the cam shaft is rapid, operating its cams and indexing before the hole in the timing disk has passed the air jets. As the hole moves past the nozzles the solid portion of the disk restricts the air and builds up the pressure to throw the time switch to its lower contact. This closes the motor circuit and the index cam moves sufficiently to raise its follower and reverse the contacts on the index switch, setting them for the next operation. This is repeated from the time-spaced holes in the disks. When the cycle is ended the cam riser opens the switch in parallel with the starting switch, breaking the timing motor circuit. Spring action returns the disk to starting position to repeat the cycle when the start button is closed.

Cooperation of the following companies in the preparation of this article is gratefully acknowledged: The Bristol Co., Waterbury, Conn.; The R. W. Cramer Co. Inc., Centerbrook, Conn.; Cutler Hammer Inc., Milwaukee, Wis.; General Electric Co., Schenectady, N. Y.; Haydon Manufacturing Co., Torrington, Conn.; National Time & Signal Corp., Detroit; Reynolds Electric Co., Chicago; Taylor Instrument Co., Rochester, N. Y.; Ward Leonard Electric Co., Mt. Vernon, N. Y.; Warren Telechron Co., Ashland, Mass.

Fig. 6—No load from switch actuation is imposed on this timing motor. Switch cams are operated separately





Part IV—Integration

APPARENTLY first invented by Hermann and Lammle of Munich in 1814, the classical mechanism for performing integration is the two-disk integrator. It was further developed by Poncelot and Morin in France some twenty years later for use in an integrating dynamometer. As shown in *Fig.* 36, one disk is rotated by quantity x. Another disk whose axis is at right angles to the first is in frictional contact with it. This second disk can be moved radially over the first by means of a suitable rack or screw-driven yoke; the shaft on which it is mounted is square or splined, so that rotation of the second disk is transmitted at any location.

Analysis of the mechanism is as follows: Let x = rotation of input disk, $y = r$ = radial position of output disk, z = rotation of output disk, and R = radius of output disk. Then

$$R\,dz = y\,dx$$

$$dz = \frac{1}{R} y\,dx$$

$$z = \frac{1}{R}\int y\,dx$$

Or, if the radius of the output disk, R, is taken as the unit of measurement, the equation may be written

$$z = \int y\,dx$$

The traditional form of disk integrator, as shown in *Fig.* 36, has a serious practical disadvantage which confines it to light service: Output torque is limited by the adhesion between the two disks, which in turn is determined by the pressure between them. However in order to change the radial position of the output disk it is necessary to slide it over the face of the driving disk, which means that the friction must be kept to a minimum; thus the two requirements for good operation are antagonistic.

Providing Greater Power Capacity

BALL INTEGRATOR: To overcome the foregoing defects, a markedly improved mechanism known as a ball integrator[9], *Fig.* 37, was developed some years ago. In this integrator the input disk drives an output roller through two intermediate idler balls. The balls are retained in position and moved radially by means of a carriage traveling on guide rails. Small guide rollers in the carriage surround the balls and keep them mounted one above the other between the roller and the disk. Since the balls act only as idlers, their dimensions do not enter into the kinematic problem

9. U. S. Patent 1,317,915.

and the speed of the output roller thus varies directly with the radial position of the ball carriage and inversely as the radius of the roller. If x = rotation of disk, y = radial position of carriage, z = rotation of roller, and R = radius of roller, then as before:

$$z = \frac{1}{R}\int y\,dx$$

This construction eliminates all sliding friction when varying the y input, for reflection will show that the balls roll on each other as well as on the roller and disk as the carriage traverses radially. Pressure between the roller, balls and disk thus can be increased greatly without interfering with the free movement of the carriage, thereby enormously increasing the adhesion and consequently the output torque. For example, such an integrator, having a 7-inch disk revolving 250 rpm, a one-inch roller and one-inch-balls, with a force of 150 pounds between roller and disk, will deliver about ¼-horsepower at the full speed position of the rate carriage. Integrators of this type have been made to handle up to two horsepower.

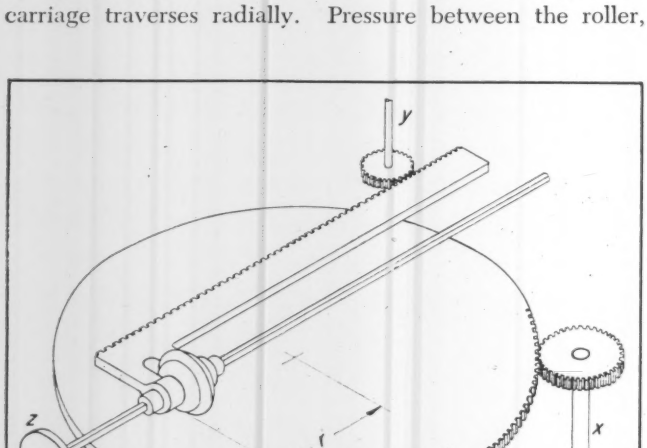


Fig. 36—Two-disk integrator in which output z is the integral of input y with respect to input x

Construction of the Ball Integrator: The roller and disk should be case hardened and ground, the case being as hard and deep as possible without giving rise to checking. This is necessary to prevent any "brinelling" as a result of the high contact pressure, particularly at the center of the disk. The balls should have the same accuracy and hardness as in ball bearings carrying comparable loads.

Suitable Thrust Bearing Necessary

Since the disk must carry considerable thrust load, a suitable thrust bearing must be provided. One way of accomplishing this is to have the underside of the disk also hardened and ground, and place a hardened circular track below it with balls between. Since the races are flat, a ball retainer in the form of a spider piloted on the center must also be used. Diameter of the race should be slightly larger than the greatest travel of the rate carriage, so that when the latter is at the extreme limit there will be no tendency to "cock" the disk, the thrust being always inside the ball circle. An ordinary small ball bearing, also piloted on the center of the disk, should be included to provide radial restraint of the disk.

In order to apply a powerful thrust between the roller and disk, the former must be arranged to float in some manner. This can be done by mounting the roller in a hinged bracket having strong springs attached, as shown in *Fig.* 37. The resulting thrust on the balls should be about 200 pounds per square inch of area of a diametral section through the ball, and the roller should have about the same diameter as the balls. It can be shown that the available output torque will then vary as the cube of the ball and roller diameter, or $T = KD^3$. Where the foregoing conditions are maintained and T is in pound-inches and D in inches, the value of K is in the neighborhood of 10.

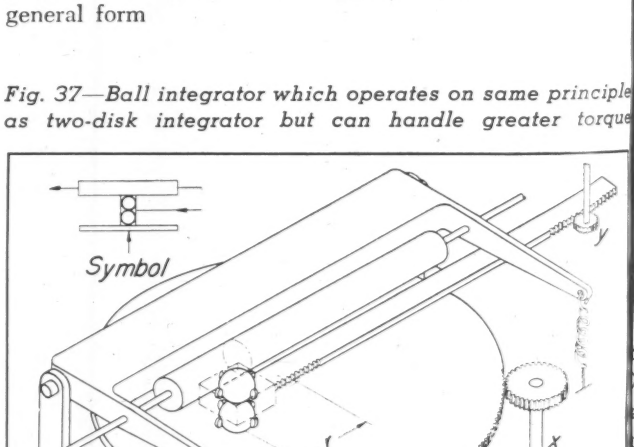
It is desirable to coat the roller, balls and disk with a film of light grease in order to prevent rust and minimize any friction between the balls and the carriage. This will not result in any appreciable loss of adhesion, since the high pressure squeezes the grease from the point of contact.

Compensating for Creep

Although slipping is almost negligible with this type of integrator for torques up to the limit of adhesion, tests have shown that what slipping occurs is in the form of slight creep approximately proportional to the torque. (When the limit of adhesion is approached, slipping increases more rapidly.) If the imposed torque increases in an essentially uniform manner, even this slight creep may often be compensated by making the roller a trifle undersize, or even tapered. The amount to take off can be determined by first conducting tests with a roller having the theoretical dimensions.

Modifications of the Ball Integrator: These integrators have been modified by making the output member of other form than that of a cylinder in order to obtain special laws of operation. For example, the output member may be made conical, *Fig.* 38*a*, both members may be conical, *Fig.* 38*b*, or both members may be disks with displaced axes, *Fig.* 38*c*. These types all follow a law of the general form

Fig. 37—Ball integrator which operates on same principle as two-disk integrator but can handle greater torque



$$z = K_1 \int \frac{y\,dx}{K_2 \pm y}$$

The reader will be able to derive readily the geometrical significance of constants K_1 and K_2.

If the x input drives the roller, with the output coming from the disk, the device follows a reciprocal law:

$$z = \int \frac{dx}{y}$$

However, such an arrangement produces a high torque on the roller as y approaches zero. To obviate this a servomotor driving the disk with a follow-up control on the roller output, can be used[10].

VARIGEAR: This is a recent type of integrator[11] operating on an entirely different principle from the friction types described previously. Straight gearing, rather than friction, is employed, and for this reason the integration is performed in a large number of finite steps, much like the process of obtaining the area of an irregular surface by the trapezoidal rule. The steps by which the rate input changes can be made so small that no appreciable error is present in the integrated output. *Fig.* 39 illustrates this. The dashed curve shows y as a function of x which is to be integrated with respect to x. This integral is of course the area under the curve at each value of x. The stepped curve represents the manner in which the y input enters the mechanism, by successive finite increments. These steps are actually so small that they could not be seen on a graph to this scale, over five hundred steps being required to reach the full scale value. The error at any point is the difference between the area under the stepped curve and that under the dashed curve, and at most will be approxi-

Connections for Four-Stage Varigear

Step	D-1	D-2	D-3	D-4	Ratio
0	H	H	H	H	0
1	H	H	H	C	1/16
2	H	H	C	H	2/16
3	H	H	C	C	3/16
4	H	C	H	H	4/16
5	H	C	H	C	5/16
6	H	C	C	H	6/16
7	H	C	C	C	7/16
8	C	H	H	H	8/16
9	C	H	H	C	9/16
10	C	H	C	H	10/16
11	C	H	C	C	11/16
12	C	C	H	H	12/16
13	C	C	H	C	13/16
14	C	C	C	H	14/16
15	C	C	C	C	15/16

mately the area of the last small triangle formed by the dashed curve and the stepped curve.

Schematic diagram shown in *Fig.* 40 will assist in understanding the theory of the varigear. Differentials *D*-1, *D*-2, *D*-3, and *D*-4 are connected in series, with one input of each connectable to the x line through a clutch. When not connected the input is held. Assume only the input to differential *D*-4 to be connected. Then the output on the spider of *D*-4 represents $\frac{1}{2}x$; after going through *D*-3 it becomes $\frac{1}{4}x$; after *D*-2, $\frac{1}{8}x$; and after issuing from *D*-1 it is

10. U. S. Patent 2,248,072
11. U. S. Patent 2,177,611

Fig. 38—Schematic diagrams of modifications of the ball integrator to obtain special laws of operation

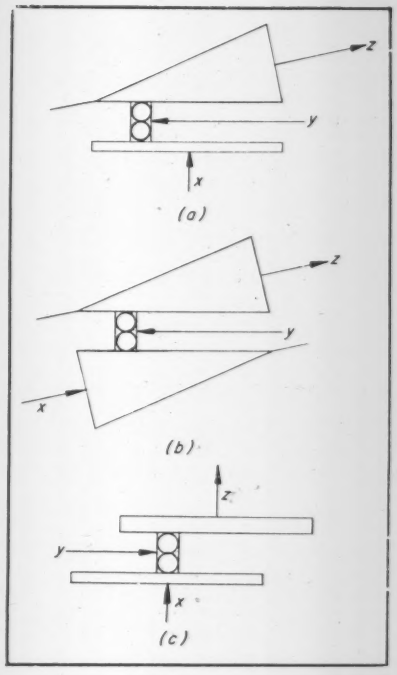
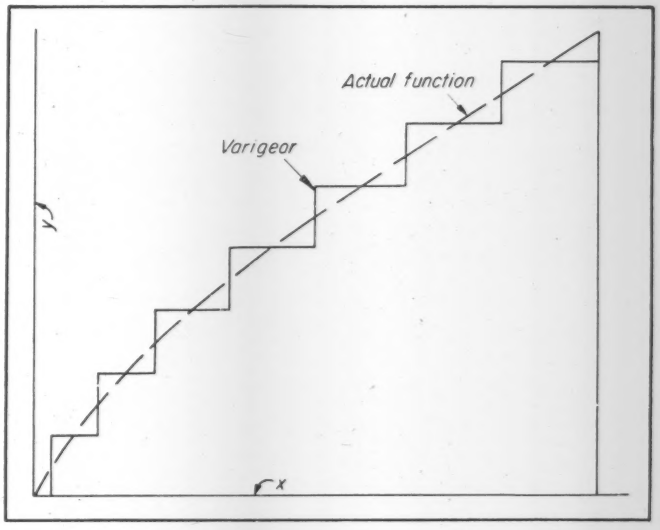


Fig. 39—Below—Comparison of the action of a varigear integrator with the actual function which it is intended to approximate



$\frac{1}{16}x$. Thus with this connection the rate (y) is $\frac{1}{16}$. In like manner it can be seen that with only *D*-3 connected the ratio will be 2/16; with *D*-3 and *D*-4 both connected it will be $\frac{3}{16}$, and so on. A table may now be made up showing the proper connections for each differential for progressive uniform increases in ratio. In the accompanying table, *H* stands for "held" and *C* for "connected" (to the x input).

Inspection of the above table shows that there is a definite pattern by which the connections are made: *D*-4 is connected every other step, *D*-3 two out and two in, etc. Consequently the clutches are operated by cams through Geneva stops driven by the y input, so as to cut in and out in the proper sequence. *Fig.* 41 shows one form of clutch, operated mechanically. Magnetically operated clutches might also be used, thereby reducing the effort required on the y input.

Reflection will show that the number of steps or intervals is a function of the number of differentials, in fact

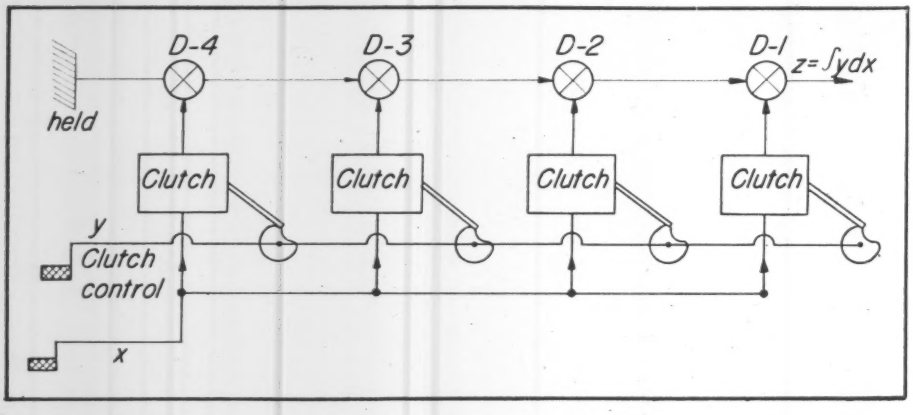


Fig. 40 — left — Varigear employing four differentials shown schematically. Such a mechanism provides fifteen steps

it is one less than 2^n, where n is the number of differentials; the case just considered thus has 15 steps. The varigear shown in *Fig.* 41 contains nine differentials and consequently has 511 steps. This photograph also indicates the manner in which the differentials are "stacked", producing a very compact unit.

The varigear by itself, will of course, accommodate rates of one algebraic sign only. However, by using the "zero shift" expedient now familiar to the reader, both positive and negative values can be handled readily. *Fig.* 42 indicates how this is done. A constant, k, is added to the y input, equal to the most negative value of y. The varigear output is thus

$$\int (y+k)dx \equiv \int y\,dx + kx$$

The kx term is then cancelled out by subtraction through a differential connected to the x input, leaving:

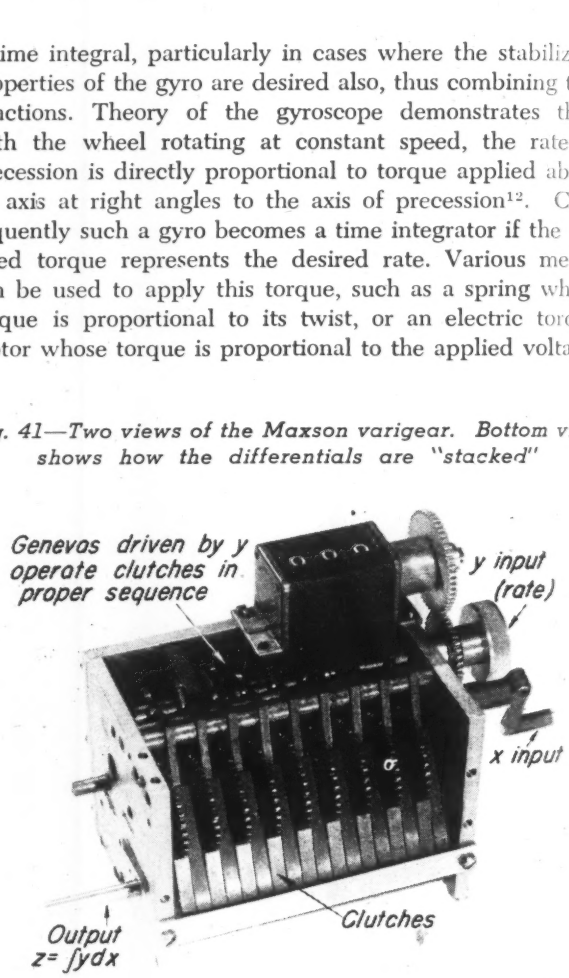
$$\int y\,dx = z$$

INTEGRATION WITH RESPECT TO TIME: In the mechanisms considered thus far, the quantity x can represent any independent variable. In many cases, perhaps in the majority of cases encountered in practice, this variable is time. In such instances the disk input is revolved at constant speed, and the integrator becomes simply a variable-speed drive, in which the function to be integrated (y) represents the rate, or speed. Any variable-speed drive may, in fact, be considered a time integrator of sorts. Whether a given type could be used in computing service would depend upon its characteristics, such as linearity of rate setting, rapidity of response, etc. Some variable-speed drives have an inherent delay between the moment the rate is set and the time the drive finally reaches the speed set in.

In the Ward-Leonard drive, for example, the generator field time constant and motor armature inertia time constant would interpose such a delay, which might produce too much error in some cases. The ball integrator has no such inherent error, at least up to the point where the roller actually slips; of course if the acceleration is too high the inertia load might impose a torque above the slipping value.

The precession of a gyroscope has been used to produce a time integral, particularly in cases where the stabilizing properties of the gyro are desired also, thus combining two functions. Theory of the gyroscope demonstrates that, with the wheel rotating at constant speed, the rate of precession is directly proportional to torque applied about an axis at right angles to the axis of precession[12]. Consequently such a gyro becomes a time integrator if the applied torque represents the desired rate. Various means can be used to apply this torque, such as a spring whose torque is proportional to its twist, or an electric torque motor whose torque is proportional to the applied voltage.

Fig. 41—Two views of the Maxson varigear. Bottom view shows how the differentials are "stacked"



12. For proof of this, and other details of gyro theory, the reader is referred to any standard textbook, such as "Mechanics of the Gyroscope" by R. F. Deimel or "Applied Gyrodynamics" by E. S. Ferry.

The gyro can be made to precess about two axes simultaneously, and thus integrate two rate components of the angular movement of a point in space. This scheme has been used in certain fire-control instruments[13] to "generate" continuously the bearing and elevation of an aircraft target on the basis of its angular rates, and simultaneously stabilize the sight or gun against rolling motion or maneuvering of the vessel. The motion of the gyro is customarily followed up by a set of so-called power gimbals placed outside the Cardan suspension of the gyro, since no appreciable restraint can be placed on the gyro, or "sensitive element", itself without causing precessional errors. The movements of the power gimbals then represent the integrated rates. It might be noted that it is not necessary to have the power gimbals oriented with respect to the same axes as the gyro rates. For example, the gyro might precess in response to rates in and perpendicular to the slant plane of a target, while the power gimbals represent motion in and perpendicular to a deck plane. Thus the trigonometric conversions from motion in one plane to motion in another can be made automatically in the follow-up process.

13. U. S. Patent 1,936,442.

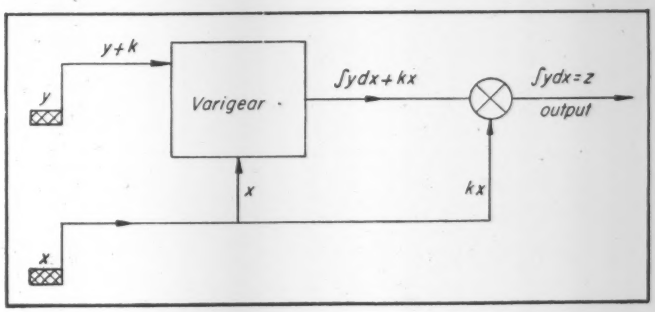


Fig. 42—How negative values of the rate, y, can be handled by the varigear, using a differential

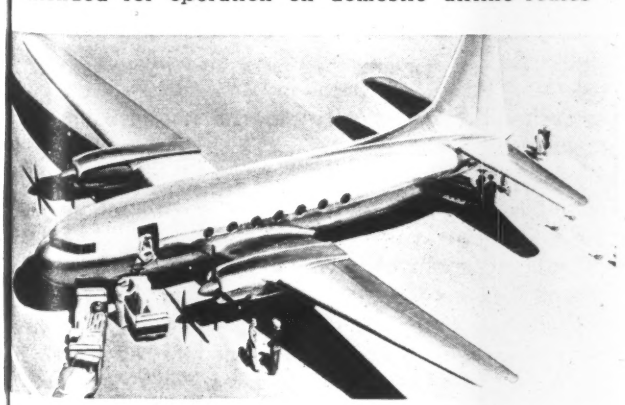
Mechanisms for the solution of differential equations, and for performing differentiation, will be discussed in Part V of this series, to be published next month.

New Airliner Designs Compared

WHAT TWO independent groups of designers, working to similar specifications, have evolved as their respective ideas of the best machine to do the job, is illustrated in the accompanying cuts. Each of the two planes pictured will seat 30 passengers and will cruise at 270 to 275 miles per hour—approximately 90 miles per hour faster than current airline schedule speeds. With these characteristics in common, it is interesting to observe how closely the two designs resemble one another, as revealed by the illustrations and in the accompanying table.

Both planes employ the Pratt & Whitney R-2800 Double Wasp, which is a twin-row 18-cylinder radial engine delivering 2100 hp at takeoff and up to 1700 hp when cruising. Using water injection, 2400 hp would be available for emergency takeoff, while the addition of a jet-type engine exhaust system could be used to increase cruising speeds as much as 20 miles per hour.

Propellers are four-bladed with reversible pitch, permitting the development of reverse thrust to assist braking on short or icy runways. Tricycle landing gear with dual



Martin model 202 airliner, above, and Convair 110, below, represent two modern designs for twin-engine transports intended for operation on domestic airline routes

Comparison of Specifications

Manufacturer	The Glenn L. Martin Co.	Consolidated Vultee Aircraft Corp.
Ceiling on 2 engines, feet	30,000	29,100
Designation	Model 202	Convair 110
Passenger capacity	30	30
High speed, mph	306	322
Cruising speed, mph	270	275
Stalling speed, mph	80	79
Ceiling on 2 engines, feet	30,000	29,100
Operational ceiling on one engine, feet	16,000	16,100
Normal gross weight, pounds	34,300	32,300
Weight empty, pounds	22,023	20,680
Wing span	92ft 9in	91 ft
Wing area, square feet	860	820
Normal takeoff power, two engines	4200	4200
Propeller diameter	13ft 6in	12ft 2in

main wheels are employed on both ships, facilitating maneuvering on the ground and maintaining a level floor when parked or taxiing.

So far as passengers are concerned, the most obvious difference in the two planes probably would lie in the loading arrangements. While the Convair has a retractable stairway located beneath the tail, the Martin has doors on both sides of the fuselage. In both cases, rapid loading and unloading of passengers and cargo at the same time is possible. On both planes the passengers are seated two abreast on each side of the aisle, the seats being provided with adjustable head rests.

International Standards Conference Makes Good Progress

NUMEROUS developments of interest to the design profession resulted from discussions which took place at the recent Ottawa conference on unification of engineering standards. The conference, held under the auspices of the Combined Production and Resources Board, brought together many notable engineers of the United States, United Kingdom and Canada.

A solid basis for agreement was reached on various aspects of the problems of standardization of screw threads, pipe threads, drawing practice, metrology, and limits and fits, and it is anticipated that final proposals for specifications will be developed through the established channels set up for this purpose in each of the countries involved.

Differences between British and American screw thread forms, which caused tremendous production and supply difficulties during the war, were resolved to the point that the delegates were in a position to return to their respective countries with a suggested specification for a basic thread form that would provide a unified standard for all countries employing the "inch" system. This proposed form is what might be termed a modified truncated form and incorporates the sixty-degree angle of thread. It was felt at the conference that the suggested change would involve the minimum amount of departure from existing practice consistent with the object in view—a common standard for general purpose threads. The proposal on the basic thread form was the most outstanding accomplishment of the conference and exemplifies the spirit of collaboration that prevails among the engineering professions of the three countries.

LACK OF standardized engineering practice between the United States, Britain and Canada during the war resulted in production delays, wasted opportunities and high costs. At the recent international conference held in Ottawa great strides were made toward the unification of standards, as summarized in the accompanying brief report. Eventual results of such combined efforts cannot fail to be of far-reaching benefit, both in peacetime collaboration and in the event that future wars cannot be avoided

Agreement was reached also on acme and stub-acme threads of the type used on machine tools, aircraft and other machines where a traverse motion is required. Submission of these specifications to industry through the national standards bodies in the three countries is necessary, but representatives of each believe that an "A-B-C" standard will speedily be approved.

Delegates to the conference reached a mutual understanding on specifications for small screws such as are used in watches and clocks, as well as on threads for microscope lenses. Agreement also was reached on a specification for fine-motion screw threads of the type employed in micrometers, and plans were initiated to resolve the differences existing in specifications for the various types of screws used in optical, electrical and scientific instruments.

In connection with what might be termed special thread forms, engineers from the three countries agreed upon certain aspects of the buttress thread form. Considerable progress was made with regard to high-duty studs as utilized in light alloys but the diversity of practices, particularly between the United States and Britain, made it impossible to formulate definite recommendations at this time.

Differences in drafting practice, particularly as followed by the same two countries, were difficult to reconcile in the effort to reach a mutually agreeable basis at the conference. It will be remembered that these differences in drafting procedure had caused innumerable delays during the war, typical of which were the time lost due to the redrawing required for such equipment as Rolls-Royce engines, bomb sights, Bren and Bofors guns designed in one country and manufactured in another. Since that period considerable discussion and exchange of data have taken place between Britain and the United States to help clear the way for a more unified policy.

Dimensioning and tolerancing of drawings constituted the basis for the primary discussion on engineering drawing, but in view of the scope of the project and—as previously indicated—the divergence of practices in the different countries, these discussions could necessarily be only exploratory in character. It was recommended unanimously, however, that the subject be pursued actively with a view toward ultimate unification of practice.

AT A RECENT meeting in New York a constitution for a new and expanded international standards organization was drafted and a new name, the International Standards Coordinating Association, was adopted. The meeting had been called by the United Nations Standards Coordinating Committee, organized more than a year ago to promote more uniform general standards among the Allied nations.

Questions tentatively discussed included the adoption of the inch or metric system of measurement and the use of the English or French language as the official language of the organization. Further exchange of views will take place prior to and at a meeting in London next Spring.

Fig. 1—Bank of ticketing units automatically records billing data for toll calls, obviating central operators. Equipment is superhuman in that it catches its own mistakes

Automatic Ticketer Makes Infallible Records

AUTOMATIC ticketing for dial telephones makes possible the placing of "toll calls" by direct dialing without the aid of a central operator as is the usual procedure in most localities. Developed by Bell Telephone Laboratories this new equipment is now serving Culver City which is part of the extensive Los Angeles metropolitan area of nearly a million telephones.

Extending the speed and convenience of dial operation to toll calls the new system automatically prints a ticket for each call, showing the number of the calling and called subscribers, time of con-

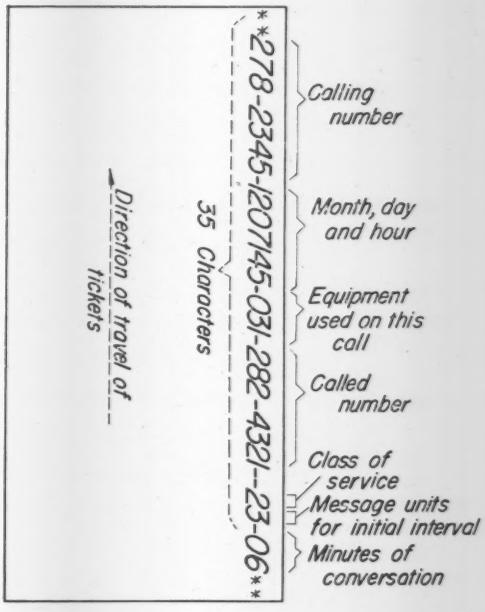


Fig. 2—Mechanically prepared ticket contains all the information required for record and billing

versation and other information required for charging the call. Switching equipment utilized is of the step-by-step type, divided into "originating switches" and "terminating switches". The former utilize the first few digits of the called number to route the call to an interoffice trunk, the remaining digits serving to complete the call in the distant office. The terminating switches route incoming calls to the proper subscriber. Some of the aparatus required to secure the printed information is associated with the call until disconnect occurs, but other equipment such as the "day-and-hour calendar" is required only for short intervals and may serve a large group of ticketers.

One Ticketer Employed for Each Trunk

In *Fig.* 1 is shown a bank of ticketers which automatically prints a complete record of the essential data pertaining to each call. One of these ticketing circuits is permanently associated with each trunk line used. As soon as a ticketing circuit is seized, a "sender" is connected to it and begins recording the digits dialed by the subscriber. The sender in turn is associated with an "identifier" to get the necessary information. This identifier determines the office code and the subscriber's number. With this information the sender connects to the ticketer and starts printing the ticket. Apparatus forming part of the ticketing circuit starts to time the call as soon as the called subscriber answers, and prints the chargeable time at disconnect. A complete ticket, mechanically prepared in this way is shown in *Fig.* 2 with the digits identified to show the complete record obtainable.

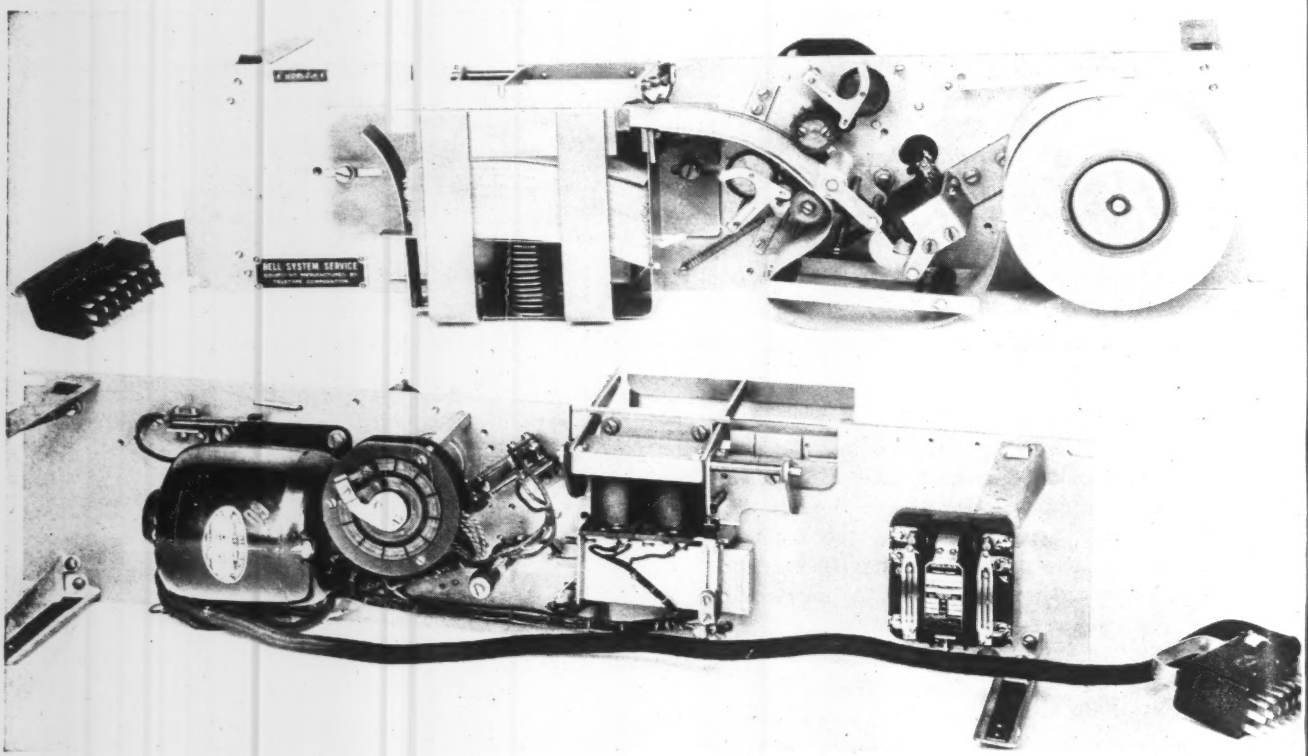
Front and back views of a ticketer unit are illustrated in *Fig.* 3 and its operation is shown schematically in *Fig.* 4. Paper for the ticketing, supplied from a roll, is passed through drive rollers, thence between the lower rim of the type wheel and a printing hammer, and then through guides to the cutting knife and hopper. The type wheel carrying twelve characters—ten digits from zero to nine, a dash and an asterisk—is mounted on a shaft which also carries an index wheel driven through a friction clutch by a small motor, and a pair of interconnected brushes. One brush rides on a contact ring, the other over a set of twelve stationary segments. Each commutator segment corresponds to one character on the type wheel and, when the brush is on any particular segment, the character corresponding to that segment on the type wheel is in position for printing. Voltage applied to a segment by the control circuit energizes the print magnet which lifts the print hammer to force the paper against the character. With the same motion a metal finger called the "stabber" is pressed between two teeth on the index wheel to hold the type wheel stationary while the impression of the character is being made. As the magnet releases, a finger connected to the armature rotates a ratchet on the drive roll to step the paper ahead to the next printing position.

Friction Clutch Permits Stopping of Type Wheel

Continuous running of the motor in spite of the intermittent rotation of the type wheel is permitted by slipping of the clutch. Contacts operated by the armature of the print magnet indicate when the magnet has completed its operation so that the voltage can be removed, and also when the magnet has been fully released so that the printing of the next character can be started. The type wheel rotates at about 375 rpm and printing is at the rate of about seven characters per second.

The number of sender units, *Fig.* 5, required in a system is dependent on the busy-hour traffic. When there are not more than 100 trunk lines, each sender is directly

Fig. 3—Front and back views of ticketing units. This ticketer keeps an infallible record of all toll calls handled



associated with one trunk finder. For larger systems each sender is provided with two trunk finders, each belonging to a separately multiplied group, so arranged that the time required for connecting a sender to a trunk is as short as possible.

By the time a sender has been connected to a trunk circuit, from two to four digits will have been dialed by the subscriber. From one to three of these digits are used in reaching the trunk circuit. After the sender has been connected, it records on register relays all subsequent digits dialed, but to be able to retransmit the office code and to print the complete called number on the ticket, it must also determine the digits dialed before it was connected to the trunk. To accomplish this the sender connects itself to one of the identifiers. This circuit determines, from the relays in the calling line, the digits already dialed and the digit registered in the trunk circuit and transfers all of this information to the sender. To differentiate between subscribers on a two-party line, a sensitive relay discriminates between the high-impedance ringer of one subscriber and the ringer on the other. To avoid errors due to failure

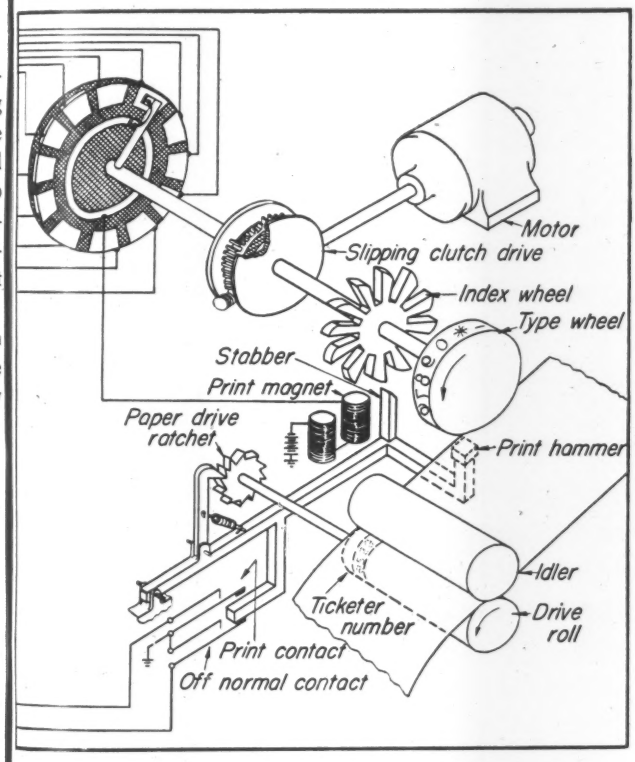


Fig. 4—Schematic diagram of ticketer shown in Fig. 3

of the circuit, the sender tests this relay at the end of each call. In the event of failure the sender is held out of service and an alarm is sounded.

Incorporated in the sender is a condenser-timed pulsing circuit. As soon as the office-code digits are registered, this circuit starts generating pulses for establishing the connection to the called number. Counting relays, which are switched successively to groups of register relays by steering relays, control the number of pulses sent out to the switches for both the office code and numerical digits.

By the time the subscriber has dialed the second digit into the sender, the identifier has transferred to it the sub-

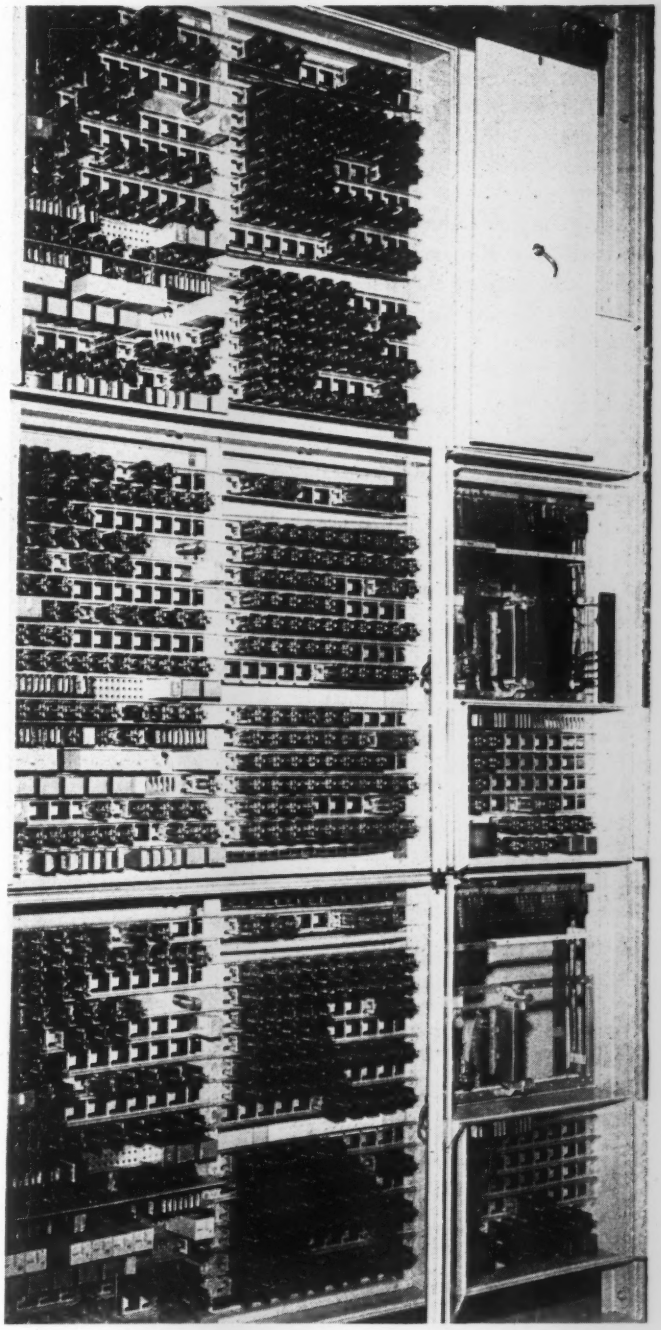


Fig. 5—Three senders are mounted one above the other

scriber's directory number and other subscriber rate data. Having recorded all this information the sender establishes another circuit to the trunk through preference relays and a multicontact relay. Through this connection pass the printer control leads and the twelve character leads. In this way the sender controls the printing of the ticket in the trunk circuit. A simplified schematic of the circuit is shown in *Fig. 6*.

At the beginning of printing, the selector is resting on its first position. The ground from a back contact of the control relay is carried through the selector to one of the segments on the printing commutator. During this period, the brush of the printer is continuously rotating around the twelve segments and, when it reaches this particular segment, the ground is extended to the printing magnet,

completing the circuit for its operation.

As the magnet operates, it stops the brush, prints the character and closes the contact operating the control relay. This relay in turn opens the ground connection to the commutator segment through the selector and immediately afterward operates the selector magnet. In the meantime, opening the ground to the commutator has released the printing magnet, allowing the brush to rotate, and also has released both the control relay and the selector magnet which now moves the selector one step ahead. A similar cycle then begins but with the ground extended over the second position of the selector.

Is Always in Printing Position

The circuit for printing the day and hour digits includes seven rotary selectors. One pair of these supplies the two digits to indicate the month, another pair for the day and a third pair for the hour. The seventh selector supplies tenth-hour indications and is operated by a contact that is closed every six minutes by a continuously rotating synchronous motor. The various selectors are always in the proper position to indicate the correct digits. As the printing selector moves from one position to the next, the ground is carried through the successive selectors and is directed to the proper character leads.

After finishing with the day and hour circuit, the sender prints the characters to indicate the equipment used for the call, the called line and the number of message units for the initial interval. With the printing of these digits the sender disconnects itself from the trunk circuit. Digits indicating the conversation time and the asterisks denoting the end of ticketing are printed by the trunk circuit at the termination of the call.

The identifier associated with the sender is an elaborate circuit comprising several hundred U-type relays, a few multicontact relays, vacuum-tube detectors, an oscillator, and cold-cathode-tube timers, together with the usual circuit elements such as condensers, resistors and transformers. Because of the short time an identifier is held for a call, a group of two or three is usually capable of serving all the central-office units in a building.

After a sender has seized an identifier and indicated to it which trunk circuit is being used, the identifier connects to this circuit through a multicontact relay and connects a low-frequency signal from its oscillator. Through a selective condenser-resistance network and ten vacuum-tube detectors the identifier is able to determine and record the digits of a call and transfer them to the register relays in the sender for controlling the printing.

Safeguards Assure Accuracy

This automatic ticketing equipment is provided with a large number of safeguards to insure proper operation. When the identifier fails or cannot identify the calling number, the sender will make another trial with another identifier. When it fails, it momentarily connects to the automatic trouble indicator where it leaves a complete record of the progress of the call together with a record of the principal circuits involved in the connection at the time of failure so that the trouble can be remedied quickly. These methods of continuously bringing incipient faults to light, together with arrangements for testing the numerous operating features, provide the maintenance staff with means for insuring a high degree of accuracy in the performance of the ticketing system.

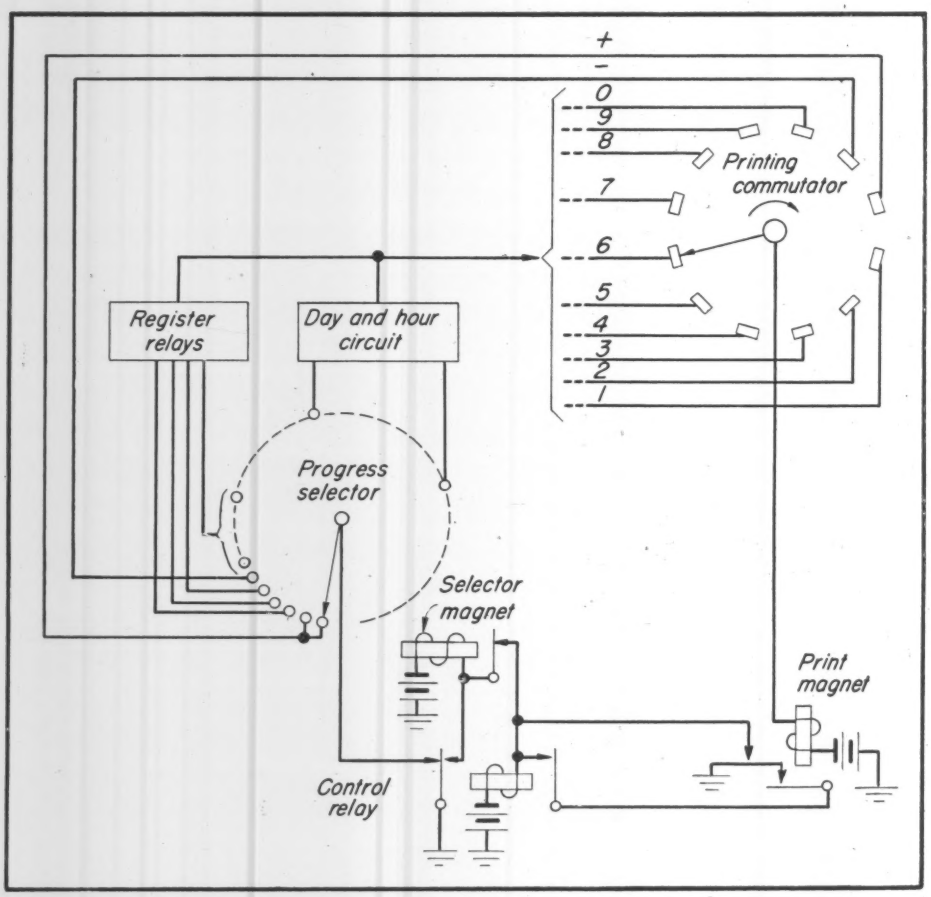


Fig. 6—Simplified circuit for sender, showing how it operates the ticketer mechanism

MACHINE DESIGN

Editorial

Design and Recovery

SHORTAGE of engineering personnel is being seriously felt in the machine-building industry. On every hand there are striking indications that the reconversion program on which this country—and much of the rest of the world—stakes its immediate future, is likely to be held back through the lack of trained engineers.

Virtually superhuman efforts on the part of the engineering profession overcame similar manpower shortages throughout the war. Of assistance was the fact that no great difficulty was experienced during that time in obtaining deferment from the draft for technically trained men. With the end of hostilities, however, and the consequent cancellation of draft deferment, many young engineers are being called to military service who might better be left to help in the new design and development programs that are essential in insuring speedy return to normal peacetime conditions.

Even though production of previously designed models on a vast scale is the primary requisite in reaching a good measure of full employment, there still will remain to be combatted that period when sales are liable to drop off and new models will be needed. It is to insure against the eventuality of a slump occurring at that time that engineering departments of machinery companies should be given all possible assistance in connection with their manpower problems.

The present situation will be alleviated to some extent by the return of veterans to design and development work. On the other hand the customary influx of young engineers into this field will be greatly reduced for a long time to come in view of the relatively small enrollment in engineering colleges, other than for military purposes, during recent years. Dr. Vannevar Bush, head of the Office of Scientific Research and Development, estimates that there is a current deficit of 150,000 science and technology students who before the war would have received bachelor's degrees.

It is apparent that new developments will be retarded and that in consequence recovery will be drastically affected unless steps are taken in every way possible to build up and maintain the engineering staffs of machinery manufacturing companies.

L. E. Jermy

Outstanding Designs

Slide Projector

Slides and lamp of new slide projector made by Bell & Howell are cooled by induced-draft fan cooling system. Slides are further protected from lamp heat by three heat-absorbing filters in condenser system. Lamp socket is at top of projector and so arranged that when hinged top of socket is opened for lamp removal all socket parts are electrically isolated. Lens is focused by rack and pinion with locking knob concentric with focusing knob. Projector is tilted by a knob-operated, self-locking rack and pinion extension of feet at front or back of projector. Motor is supported on synthetic rubber bushings.

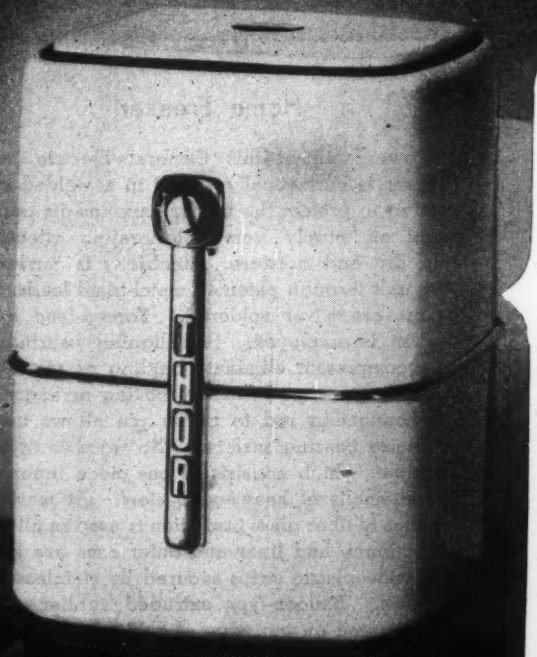
Electronic Dictating Machine

Recording unit of this electronic dictating and recording machine manufactured by Dictaphone Corp. is located at the top of the cabinet and consists of a combination crystal recorder-reproducer, carriage and feed screw, and a universal electric motor drive. Other accessories are a warning buzzer to prevent dictation when in the "neutral" or "record" position, a warning bell that indicates the end of the cylinder is being approached, and an automatic indicator that permits indications by a flick of the finger as to the length of letters and corrections to be made.

A bin is provided in the lower section of the cabinet for storage of cylinders and correspondence. The amplifier, also housed in the base of the cabinet, consists of three stages, only two of which are used for dictation. The third stage is brought into play when recording telephone messages.

Rotary Ironer

Shoe of this automatic rotary ironer made by General Electric is chromium plated on 110 square inches of ironing surface and has long-life heating elements. Ironer base is one-piece, welded-steel with rounded corners and rubber bumper-band. Motor head mounted on base is smaller than roll to facilitate ironing large pieces. Automatic control handle in operating head facilitates the starting and stopping of roll, and application of pressure. It also permits operation with either hand or knees. Release lever is provided to move shoe away from roll in case current goes off.



Automatic Washer

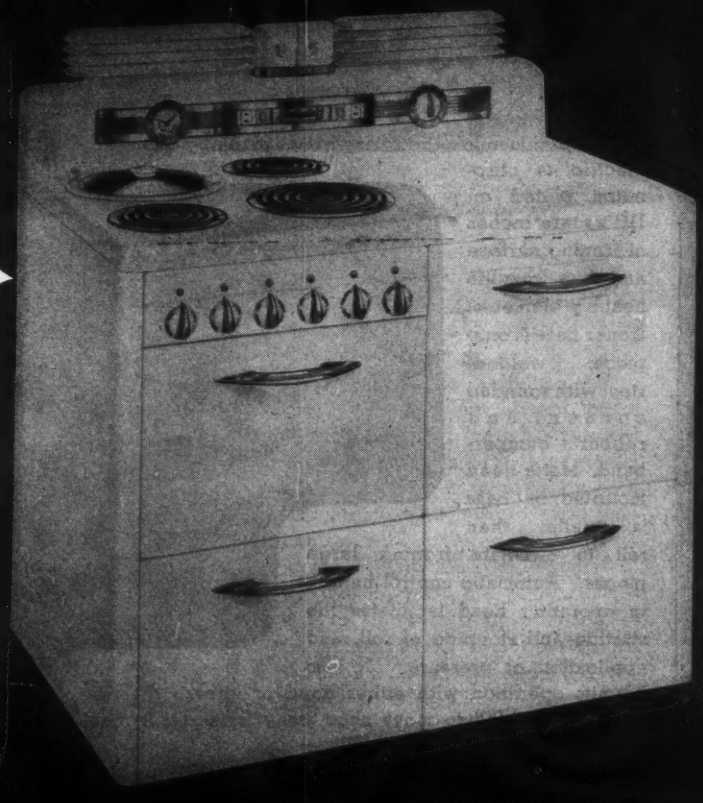
Of the agitator-spinner type, this combination clothes and dish washer made by Hurley Machine Division of Electric Household Utilities Corp. has cast aluminum agitator and enameled steel spinner bowl, each operating on a separate vertical shaft, one within the other. Dishwasher parts are stainless steel and aluminum and include a spinner bowl and set of hollow steel fingers mounted on the agitator drive shaft. Over these are placed wire baskets for use when dishes, cups, etc., are being handled.

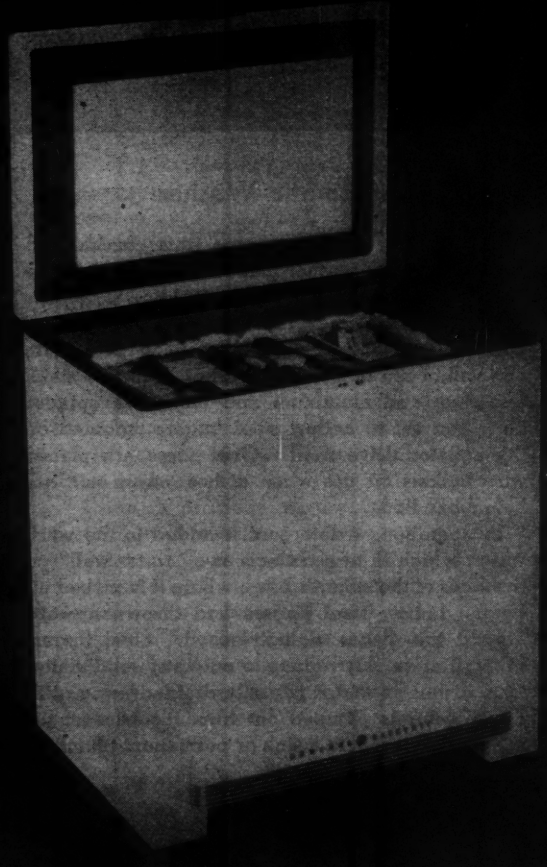
In operation, a detergent is added to the wash water, which in turn collects as a "water wall" on the sides of the spinner bowl, where it is picked up by the hollow steel fingers and thrown upward against the dishes at high speed. Steel fingers of the unit quickly reduce to pulp any solid matter from dishes so that it is easily drained away. All drain water is pumped out from the base of the machine, either into a sink or permanent plumbing drains.

Electric Range

Featuring modern lines and great automaticity, this range, manufactured by Edison General Electric Appliance Co. Inc. has clock-thermostat controlled oven and illuminated switch dials. It is of one-piece, all-steel welded construction with porcelain finish on all exterior and interior surfaces, and is blanket-insulated on the six sides of the oven. Appointments include a warming compartment, roasting chart permanently baked into a storage drawer, time-chime to indicate minutes, and double Venetian lights which illuminate the surface of the range.

This range, like the other machines pictured on these pages, combines function with beauty of design such as extends beyond normal requirements to make the equipment adaptable either to plain or luxurious surroundings.





Home Freezer

Power unit of this General Electric home freezer is hermetically sealed in a welded steel casing to protect the mechanism and its permanent oil supply from deteriorating effects of air, dirt and moisture. Electricity is carried to the unit through patented metal-glass leads. All joints are silver soldered. Forced-feed lubrication is employed. Self-aligning bearings in the compressor eliminate binding or scoring of moving parts, and flexible locking arrangement of connecting rod to piston pin allows use of oversize bearing surfaces. No wood is used in cabinet, which consists of one-piece inner and outer shells of heavy-gage steel. At least 3¾ inches of fiber glass insulation is used in all parts of cabinet, and liner and outer case are joined by wide plastic strips secured by stainless steel screws. Balloon-type extruded rubber gasket is mounted on top edge of cabinet.

(New machines listed on page 194)

Nomograph Aids Solution of Vibration Problems

By Melvin Nord and S. F. Ciricillo

SIMPLE HARMONIC vibration is characterized by four quantities: Amplitude of vibration, frequency, maximum velocity, and maximum acceleration. Only two of these are independent variables, so that when any two are specified, the others may be determined. The vibration nomograph on Page 156 provides a rapid method of making this determination. By means of a single line through the two known values, the others are found at the intersections of the line with the remaining axes.

The fundamental equation for a simple harmonic vibration may be written as

$$x = A \cos 2\pi ft \quad \ldots\ldots (1)$$

where x is the displacement at time t, A is the amplitude, or half of the peak-to-peak displacement, and f is the frequency of oscillation, cycles for unit time. The first and second derivatives of this equation, with respect to time, represent the velocity and acceleration at the time t. Thus,

$$\frac{dx}{dt} = -2\pi fA \sin 2\pi ft \quad \ldots\ldots (2)$$

and

$$\frac{d^2x}{dt^2} = -4\pi^2 f^2 A \cos 2\pi ft \quad \ldots\ldots (3)$$

The maximum velocity, v, and the absolute value of the maximum acceleration, a, therefore are

$$v = 2\pi fA \quad \ldots\ldots (4)$$

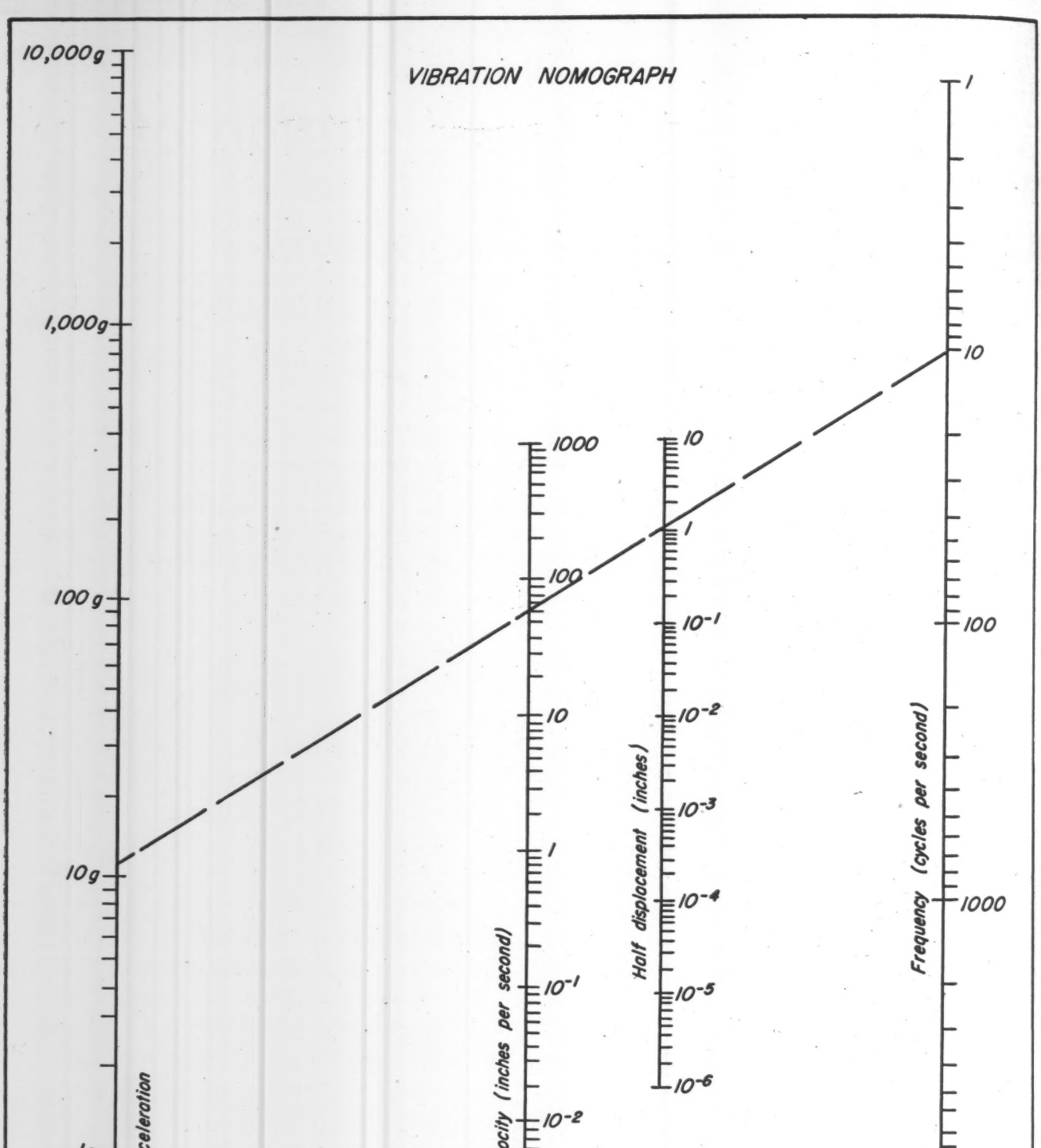
and

$$a = 4\pi^2 f^2 A \quad \ldots\ldots (5)$$

The two characteristic equations for a simple harmonic vibration may then be written as

$$\left.\begin{aligned} v &= 2\pi fA \\ a &= 2\pi fv \end{aligned}\right\} \quad \ldots\ldots (6)$$

The nomograph is based on Equations 6. As an example of its use, the dotted line shows that if the maximum velocity, v, is 67 inches per second, and the frequency, f, is 10 cycles per second, then the half displacement, A, is about 1.1 inches, and the maximum acceleration, a, is about 11 times the acceleration of gravity.


VIBRATION NOMOGRAPH
10,000g
1,000g
100g
10g
1g
0.1g
Acceleration
1000
100
10
1
10⁻¹
10⁻²
10⁻³
10⁻⁴
Velocity (inches per second)
10
1
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
Half displacement (inches)
1
10
100
1000
10,000
100,000
Frequency (cycles per second)

MACHINE DESIGN'S

MATERIALS WORK SHEET

FILING NUMBER
7.02

Manganese Alloy Cast Steels

ASTM SPEC. NO.: A148-44

Specifications of the American Society for Testing Materials (ASTM) for Manganese Alloy Cast Steels generally fix only the *minimum* mechanical properties. Properties higher than those listed can be obtained by varying the chemical compositions and by subjecting cast parts to various heat treatments.

It is suggested that the designer select the steel to be used from the standard (ASTM) specifications and, after acquainting the foundry with any additional properties required in a given part, leave the compounding of the steel and recommendations for its heat treatment in the hands of a competent foundryman.

PROPERTIES PRESCRIBED IN ASTM SPECIFICATIONS

Alloy-Steel Castings for Structural Purposes

ASTM Specification No.	Class	Heat Treatment*	Tensile Strength (min, psi)	Yield Strength (min, psi)	Elong. in 2 in. (min, %)	Red. of Area (min, %)
A148-44	A1	A	75,000	40,000	24	35
A148-44	A2	A	85,000	53,000	22	35
A148-44	B1	A or N or NT	85,000	55,000	22	40
A148-44	B2	A or N or NT	90,000	60,000	22	45
A148-44	B3	A or N or NT	100,000	65,000	18	30
A148-44	C1	N or QT	90,000	65,000	20	45
A148-44	C2	N or QT	120,000	100,000	14	35
A148-44	C3	N or QT	150,000	125,000	10	25

*A = Full Annealed; N = Normalized; NT = Normalized and Tempered; QT = Quenched and Tempered.

CHARACTERISTICS

Cast steel containing over one per cent manganese is classified as an alloy steel. The effect of manganese in cast steel is to promote high strength accompanied by satisfactory ductility, although in some cases property values are sensitive to composition changes. The three most important types of this group from the standpoint of volume produced are the medium-manganese, manganese-nickel and manganese-molybdenum steels.

Medium-Manganese Cast Steels: The three primary types constituting the bulk of medium-manganese steel castings are of the following nominal compositions (percentages): 0.25 to 0.35 carbon, 1.05 to 1.35 manganese; 0.30 to 0.40 carbon, 1.35 to 1.55 manganese; 0.30 to 0.40 carbon, 1.70 to 2.00 manganese. These castings seldom are used fully annealed, in which state they exhibit low impact and yield strengths. They show their best properties on normalizing or liquid quenching. Where tempering follows normalizing, the effect is to increase ductility and impact values with decrease in yield point and tensile strength. Values normally expected from the three main types given in the foregoing are listed in the tables. These steels are somewhat superior in creep resistance to plain carbon steels of similar carbon content, although other steels containing molybdenum or tungsten, with or without chromium, give higher values at temperatures approaching 1000 F or above.

Medium-Manganese-Titanium (titanium treated) Cast Steels: Titanium is added to medium-manganese cast steel to refine the grain and, by thus altering the critical cooling rate, make the steel less strongly air-hardening. Addition of approximately 0.05 per cent titanium to manganese steel in-

MACHINE DESIGN is pleased to acknowledge the collaboration of the Steel Founders' Society of America in this presentation. Data included are abstracted from the Society's *Steel Castings Handbook*.

creases the yield strength, ductility and impact resistance. Normally expected mechanical properties of some representative steels in this group are listed in the tables. These steels offer good properties at low cost and simplicity in heat treatment.

Manganese-Nickel Cast Steels: These usually are produced within the following limits (percentages): 0.30 to 0.40 carbon, 1.10 to 1.30 manganese, and 0.65 to 0.85 nickel. They respond well to liquid quenching followed by tempering and are well suited to differential hardening wherein the section to be hardened is immersed in water after the entire casting has been heated above the critical range. Normally expected properties of representative steels are listed in the table.

Manganese-Chromium-Vanadium Cast Steels: Main effect of the addition of vanadium to manganese-chromium steel is to increase impact resistance in the normalized and tempered condition. These steels are of the air-hardening type. Normally expected properties are listed in the table "Manganese-Chromium-Vanadium Cast Steels".

Manganese-Chromium-Molybdenum Cast Steels: These have high yield values plus good ductility. They are of two basic types, one having medium-carbon, low-chromium content, and the other having slightly higher carbon and chromium content. Analysis range covered by the first type is (percentages): 0.25 to 0.40 C, 0.30 to 0.50 Si, 1.25 to 1.50 Mn, 0.70 to 0.90 Cr, 0.30 to 0.40 Mo. Analysis range of the second type is: 0.40 to 0.55 C, 0.30 to 0.50 Si, 1.25 to 1.50 Mn, 0.90 to 1.25 Cr, 0.30 to 0.50 Mo. Steels of the first type have good properties up to 1000 F and resist creep at elevated temperatures. Because of the high mechanical properties that may be obtained in both of these steels, lightweight sections may be employed for important structural members. Where casting design permits, liquid quenching produces excellent properties. Normally expected properties of these steels are given in the table, "Manganese-Chromium-Molybdenum Cast Steels".

Manganese-Molybdenum Cast Steels: Popular low-alloy cast steels of the air-hardening type. Similar to medium-manganese steels, they have the added characteristic of high yield point at elevated temperatures, higher yield ratio at room temperature and greater freedom from temper brittleness. They also have excellent depth-hardening characteristics. Properties are similar to those of nickel-molybdenum steels except that, for a given hardness or strength, their ductility generally is slightly lower. Usual compositions fall within the ranges (percentages): 0.20 to 0.40 C, 1.10 to 1.50 Mn, 0.25 to 0.50 Si, 0.25 to 0.50 Mo. Normally expected properties are listed in the tables. Presence of molybdenum in these steels has beneficial influence on creep resistance.

Manganese-Vanadium Cast Steels: Addition of 0.10 per cent vanadium to medium-manganese steel produces marked improvement in microstructure and mechanical properties. This is evidenced in higher yield strength and particularly in better impact values. Fatigue resistance of these steels also is excellent. Usual compositions fall within the ranges (percentages): 0.25 to 0.35 C, 1.40 to 1.70 Mn, 0.25 to 0.50 Si, 0.08 to 0.12 V. Normally expected properties are listed in the tables. In thin-sectioned castings designed to permit liquid quenching, properties shown in the table, "Water-Quenched Manganese-Vanadium Cast Steel" may be obtained.

MEDIUM-MANGANESE CAST STEELS

(0.25 to 0.35 C, 1.05 to 1.35 Mn)

(normally expected values)

Composition (%) C	Mn	Si	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.	Izod Impact (ft-lb)
0.29	1.19	0.32	1650 AC	81,390	48,400	25.5	40.3	...	...
0.32	1.28	0.29	1600 AC	88,200	57,000	27.0	46.0	...	12
0.35	1.25	0.37	1650 AC	91,000	55,000	20.0	45.0	180	15
0.29	1.20	0.28	Heated 1650, 1550 AC, 700 T	77,500	50,500	32.0	55.4	...	...
0.32	1.16	0.30	Heated 1650, 1550 AC, 700 T	88,000	46,000	27.0	40.4	...	34
0.34	1.12	0.47	Heated 1650, 1550 AC, 700 T	80,500	41,000	30.0	47.4	...	...
0.35	1.25	0.33	1600 AC, 1250 T	85,000	50,000	28.0	50.0	160	25
0.31	1.30	0.39	1650 AC, 1250 T	86,500	53,000	30.0	55.0	170	...

*AC=Air cooled; T=Tempered.

MEDIUM-MANGANESE CAST STEELS, WATER-QUENCHED AND TEMPERED

(normally expected values)

Composition (%) C	Mn	Si	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Charpy Impact† (ft-lb)
0.35	1.38	0.33	1650 WQ, 1290 T	106,000	74,000	17.7	34.0	....
0.26	1.76	0.54	1650 WQ, 1290 T	85,000	57,000	24.7	41.0	30.0
0.26	1.11	0.45	1650 WQ, 1290 T	78,000	51,000	30.5	56.4	26.6
0.25	1.43	0.55	1650 WQ, 1185 T	92,000	62,000	24.1	53.2	30.0
0.26	1.36	0.51	1650 WQ, 1185 T	96,000	53,000	29.6	57.9	27.5
0.28	1.40	0.53	1650 WQ, 1220 T	83,000	65,000	25.6	57.2	15.0
0.31	1.12	0.52	1650 WQ, 1290 T	81,000	52,000	29.5	56.9	28.4
0.28	1.39	0.38	1650 WQ, 1200 T	88,250	55,000	26.0	52.2	....
0.32	1.41	0.40	1650 WQ, 1200 T	102,500	70,000	23.5	48.5	....

*WQ = Water quenched; T = Tempered; †Keyhole notch.

MEDIUM-MANGANESE CAST STEELS

(0.30 to 0.40 C, 1.35 to 1.55 Mn)

(normally expected values)

Composition (%) C	Mn	Si	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.	Impact† (ft-lb)
0.33	1.50	0.38	1650 AC	103,500	61,200	23.5	49.5	212	11(C)
0.32	1.42	0.40	1650 AC	92,000	58,300	26.0	45.4	192	14(C)
0.32	1.54	0.48	1650 AC	110,200	64,250	22.5	47.8	228	15(C)
0.37	1.44	0.28	1650 AC	98,800	61,450	22.0	44.0	202	....
0.33	1.46	0.31	1650 AC	96,000	61,000	25.5	49.3	192	13(C)
0.32	1.40	0.39	1650 FC, 1550 AC, 700 T	93,000	52,500	26.0	55.7	...	20 (I)
0.36	1.40	0.42	1650 FC, 1550 AC, 700 T	95,000	52,000	27.0	53.0	...	21 (I)
0.37	1.56	0.51	1650 FC, 1550 AC, 700 T	101,500	55,000	27.0	44.5	...	....
0.40	1.54	0.44	1650 FC, 1550 AC, 700 T	100,500	54,700	25.5	50.5	...	19 (I)
0.30	1.55	0.33	1650 AC, 1050 T	95,000	65,000	27.5	55.0	...	....
0.30	1.55	0.33	1650 AC, 1200 T	88,850	60,000	27.5	58.1	187	....
0.29	1.45	0.41	1700 AC, 1200 T	92,000	52,500	24.8	50.1	170	....
0.30	1.52	0.43	1700 AC, 1200 T	94,800	53,400	24.7	48.3	170	....
0.30	1.35	0.40	1700 AC, 1200 T	89,500	51,200	26.0	50.1	167	....
0.33	1.50	0.38	1650 AC, 1250 T	89,100	54,550	28.0	57.3	183	....
0.32	1.42	0.40	1650 AC, 1250 T	83,250	55,050	31.5	55.7	166	....
0.32	1.54	0.48	1650 AC, 1250 T	95,850	59,950	24.0	54.4	202	....
0.33	1.46	0.31	1650 AC, 1250 T	86,350	51,950	32.5	57.8	183	....
0.37	1.44	0.28	1650 AC, 1250 T	93,600	58,200	24.5	49.7	170	....

*AC=Air cooled; FC=Furnace cooled; T=Tempered.

†(I)=Izod; (C)=Charpy V-Notch.

MEDIUM-MANGANESE CAST STEELS

(0.30 to 0.40 C, 1.70 to 2.00 Mn)

(normally expected values)

Composition (%) C	Mn	Si	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Izod Impact (ft-lb)
0.32	1.76	0.28	1650 FC, 1550 AC, 700 T	103,000	53,000	25.0	56.0	29
0.34	1.85	0.28	1650 FC, 1550 AC, 700 T	110,000	63,000	22.0	44.0	..
0.34	1.68	0.31	1650 FC, 1550 AC, 700 T	103,000	55,000	25.0	51.0	21
0.35	1.75	0.50	1650 FC, 1550 AC, 700 T	111,600	68,800	25.5	51.6	17
0.35	1.75	0.35	1650 FC, 1550 AC, 700 T	107,200	66,000	26.0	57.5	25

*FC = Furnace cooled; AC = Air cooled; T = Tempered.

APPLICATIONS

Medium-Manganese Cast Steels: Widely used for castings subject to repeated shocks, such as pneumatic tool parts, high speed railway car castings, automotive, steam turbine and other pressure parts. Because these steels resist abrasion well they are used for excavating buckets, caterpillar shoes, truck wheels, tractor treads, and for other purposes where high strength and wear resistance are of paramount importance. Present trend indicates use of medium-manganese steel is diminishing in favor of the nickel-manganese, manganese-molybdenum or manganese-vanadium types.

Medium-Manganese-Titanium (titanium treated) Cast Steels: Used primarily for high-tensile railway castings including side frames, couplers, bolsters, bolster center fillers, strikers, center plates, etc.

Manganese-Nickel Cast Steels: Used for all types of castings where either hardness or toughness is desired. They are popular in road construction machinery for all sizes of castings from small gears to large machine bases.

Manganese-Chromium-Molybdenum Cast Steels: Because their high mechanical properties make possible light-sectioned castings, these steels are being used by builders of high-speed transportation units and other equipment where weight reduction is important. In particular, castings of this group having carbon from 0.40 to 0.55 and chromium from 0.90 to 1.25 per cent have excellent wear resistance with reasonable toughness. They are used in excavating and drilling equipment and for crusher rolls, gears, etc. These steels have excellent depth of hardening possibilities, and fairly heavy sections (3 to 4 inches) can be through-hardened by water quenching.

Manganese-Molybdenum Cast Steels: Available at moderate cost, these are considered general-purpose steels. Good depth-hardening characteristics make them applicable to automotive, tractor, excavating machinery and freight car castings. They are used for cutter chains, plow tips, hammer-mill hammers, sprockets and gears, christmas-tree valve bodies, valves and fittings generally, crown-block sheaves, and casing heat tubes. For many purposes these steels can be used interchangeably with nickel-manganese and nickel-molybdenum cast steels.

Manganese-Vanadium Cast Steels: These are being used as parts of railway equipment and for miscellaneous purposes where high strength, toughness, wear resistance and resistance to impact are of paramount importance.

FABRICATION

MACHINABILITY:

In general, these steels have a machinability rating of about 50 per cent as compared to 100 per cent for cold-rolled SAE 1112. Often the skin on a steel casting contains

bits of grit and sand which tend to wear cutting tools rapidly. This difficulty is circumvented, however, by making the initial cut on a casting a deep, or hogging cut. Generally, steel in the "as cast" condition is considered more difficult to machine than after it has been properly heat treated.

WELDABILITY:

Although these steels can be welded by any of the commercial processes, normal practice in the steel castings industry is to use the electric arc. All of these medium-manganese alloy cast steels should be preheated and stress relieved because of their high alloy content. In general, it is recommended that in sections greater than ½-inch, castings be preheated to about 300 F before welding and, after welding, stress relieved at 1100 to 1250 F.

HEAT TREATMENTS

All of the medium-manganese cast steels covered by this Work Sheet are air hardening and almost invariably are used in the normalized state. None are intended for use in the fully annealed condition. With the exception of manganese-vanadium cast steels when used where high impact strength is required, these steels seldom are double-normalized because the improvements resulting do not warrant the additional heating cycle. Occasionally, manganese-nickel casting steels are water-quenched and tempered to effect maximum toughness. Single-normalizing temperatures generally range from 1550 to 1650 F, often followed by tempering at 1100 to 1250 F. In double-normalizing the first temperature usually is 1600 to 1675 F; the second (when followed by tempering), 1475 to 1500 F.

MATERIAL SPECIFICATIONS

In addition to ASTM Spec. No. A148-44, medium-manganese alloy cast steels are also covered by AAR (Association of American Railroads) Spec. Nos. M-24-39 and M-201-36. Federal Specification for these steels is QQ-S-681-b grades 4A1 to 4C4.

IMPACT VALUES OF MANGANESE-MOLYBDENUM CAST STEEL

(0.34 C, 1.10 Mn, 0.18 Mo)

(test values, Charpy Impact, ft lbs)

Heat Treatment* (deg F)	Testing Temperature (deg F) 65	14	−13	−40	−94
AC 1700	9.1	5.7	...	4.2	3.3
AC 1700, T 1200	33.5	23.2	11.8	7.2	3.3
AC 1700, WQ 1600, T 1200	68.7	59.7	43.3	34.8	24.7

*AC = Air cooled; WQ = Water quenched; T = Tempered.

MANGANESE-TITANIUM CAST STEEL LOW-TEMPERATURE IMPACT PROPERTIES

(0.30 C, 1.60 Mn, 0.40 Si, 0.025 P, 0.030 S)

Low-Temperature Izod Impact:			
80 F	49 ft-lb	0 F	25 ft-lb
60 F	42 ft-lb	−25 F	17 ft-lb
35 F	37 ft-lb	−45 F	12 ft-lb
15 F	28 ft-lb	−60 F	7 ft-lb
Tensile Strength (psi)			96,650
Yield Point (psi)			71,950
Elongation in 2 Inches (%)			25.5
Reduction of Area (%)			56.5
Ratio—Yield Point/Tensile Strength			0.744
Brinell Hardness Number			197
Endurance Limit (psi)			43,000
Ratio—Endurance Limit/Tensile Strength			0.444

ENDURANCE PROPERTIES OF MEDIUM-MANGANESE CAST STEEL

(test values, 0.35 C, 1.71 Mn)

Heat Treatment* (deg F)	Tensile Strength (psi)	Endurance Limit (psi)	Endurance Ratio
As cast	81,000	32,000	0.40
1650 AC, 1525 AC	109,000	45,000	0.41
1650 AC, 1525 AC, 600 AC	104,000	45,000	0.43
1650 AC, 1525 AC, 1000 AC	104,000	45,000	0.43
1525 AC	108,000	48,000	0.45
1525 AC, 600 AC	104,000	44,000	0.42
1525 AC, 1000 AC	103,000	43,000	0.42
1650 AC, 1525 AC, 875 AC	104,000	44,000	0.42

*AC = Air cooled.

MANGANESE-CHROMIUM-MOLYBDENUM CAST STEELS

(normally expected properties)

Composition (%) C	Mn	Cr	Mo	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.
0.28	1.33	0.78	0.32	1650 AC, 1250 T	103,300	75,000	22.0	50.0	200
0.34	1.19	0.96	0.34	1600 AC, 1300 T	105,800	77,450	23.0	52.0	207
0.38	1.30	0.80	0.33	1650 AC, 1250 T	111,000	78,800	19.5	46.7	222
0.34	1.50	0.65	0.35	1650 AC, 700 T	165,950	131,900	12.0	34.8	360
0.34	1.50	0.65	0.35	1650 AC, 1000 T	153,500	110,100	15.4	37.7	343
0.34	1.50	0.65	0.35	1650 AC, 1250 T	110,400	81,000	23.0	55.8	238
0.34	1.50	0.65	0.35	1575 OQ, 1000 T	185,250	171,250	13.3	36.3	406
0.34	1.50	0.65	0.35	1575 OQ, 1250 T	113,550	93,550	23.0	56.1	256
0.27	1.39	0.75	0.33	1600 OQ, 900 T	112,000	92,500	20.0	49.8	256
0.32	1.37	0.75	0.32	1600 OQ, 1250 T	117,500	90,500	17.5	42.0	248
0.33	1.25	0.89	0.35	1600 WQ, 1300 T	115,800	83,500	21.0	50.3	227
0.42	1.28	0.94	0.40	1650 AC, 1250 T	123,000	87,000	15.7	28.5	254
0.50	1.30	1.00	0.42	1650 AC, 1250 T	138,500	103,900	13.5	19.5	282
0.47	1.38	1.07	0.43	1600 OQ, 1250 T	160,000	129,500	10.2	23.0	325

* AC = Air cooled; OQ = Oil quenched; WQ = Water quenched; T = Tempered.

MANGANESE-VANADIUM CAST STEELS

Composition (%) C	Mn	V	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Izod Impact (ft-lb)
0.25	1.63	0.11	1650 AC, 1250T	90,000	65,000	31.0	58.5	54.0
0.27	1.47	0.12	1650 AC, 1500 AC, 1250 T	91,000	68,200	30.7	60.8	61.0
0.29	1.44	0.12	1650 AC, 1250 T	94,300	69,700	29.5	56.0	49.0
0.31	1.67	0.10	1650 AC, 1500 AC, 1250 T	101,200	67,500	28.2	57.0	55.0
0.33	1.52	0.11	1650 AC, 1200 T	100,500	67,000	27.0	54.8	41.0
0.35	1.45	0.10	1650 AC, 1250 T	102,000	72,500	26.0	53.2	35.5
0.35	1.42	0.10	1650 AC, 1500 AC, 1200 T	104,000	79,000	27.0	54.0	49.0
0.37	1.44	0.12	1650 AC, 1275 T	86,900	62,450	30.0	63.9	...
0.37	1.44	0.12	1650 AC, 1550 WQ, 600 T	180,700	159,600	9.5	27.5	...
0.37	1.44	0.12	1650 AC, 1550 WQ, 1300 T	89,700	80,150	29.0	62.9	...

* AC = Air cooled; T = Tempered; WQ = Water quenched.

MANGANESE-NICKEL CAST STEELS; NORMALIZED AND TEMPERED

(Normalized 1650 F, Tempered 1275 F)

Composition (%) C	Mn	Si	Ni	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.
0.32	1.15	0.39	0.67	94,600	57,000	24.5	48.0	180
0.34	1.30	0.44	0.71	97,500	57,250	25.0	54.7	197
0.35	1.13	0.37	0.63	91,800	55,350	25.5	54.7	179
0.36	1.21	0.42	0.68	93,600	53,350	26.0	50.9	187
0.37	1.27	0.43	0.79	99,650	55,350	24.0	50.9	197
0.38	1.20	0.36	0.83	100,800	60,250	24.0	49.7	197
0.40	1.20	0.32	0.74	100,600	64,900	25.0	52.9	197

MEDIUM-MANGANESE-TITANIUM CAST STEELS

Composition (%) C	Mn	Ti*	Heat Treatment** (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Izod Impact (ft-lb)
0.30	1.60	0.042	1650 AC, 1200 T	98,000	65,000	26.5	52.2	32
0.30	1.68	0.042	1600 AC, 1050 T	106,000	78,000	28.0	59.0	40
0.26	1.46	0.042	1600 AC, 1050 T	91,000	63,000	31.0	53.0	55
0.28	1.52	0.042	1630 AC, 1200 T	95,000	65,500	27.5	53.4	42
0.32	1.45	0.050	1625 AC, 1150 T	103,000	75,000	26.0	50.5	30

*Amount of titanium added as ferrotitanium. Usually 5 lb per ton.
**AC=Air cooled; T=Tempered.

MANGANESE-NICKEL CAST STEELS
NORMALIZED-AND-TEMPERED AND QUENCHED-AND-TEMPERED

Composition (%) C	Mn	Si	Ni	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2-in. (%)	Red. of Area (%)	Brinell Hard. No.	Charpy** Impact (ft-lb)
0.30	1.06	0.45	0.67	1650 AC,	89,900	51,900	28.0	58.5	...	...
0.30	1.06	0.45	0.67	1650 AC, 800 T	89,100	51,700	28.3	53.9	190	...
0.30	1.06	0.45	0.67	1650 AC, 1000 T	90,600	50,360	28.0	56.5	...	...
0.30	1.06	0.45	0.67	1650 AC, 1275 T	74,800	42,300	32.5	58.8	...	...
0.30	1.06	0.45	0.67	1650 AC, 1550 WQ, 600 T	162,200	141,600	8.5	26.5	380	...
0.30	1.06	0.45	0.67	1650 AC, 1550 WQ, 800 T	117,000	92,100	17.2	45.2	254	...
0.30	1.06	0.45	0.67	1650 AC, 1550 WQ, 1000 T	110,000	77,800	19.2	48.4	...	...
0.30	1.06	0.45	0.67	1650 AC, 1550 WQ, 1200 T	88,200	62,700	29.0	65.2	190	...
0.36	1.19	0.43	0.82	1650 AC	111,200	66,800	23.0	49.2	217	14.0
0.36	1.19	0.43	0.82	1650 AC, 800 T	112,000	68,100	23.0	50.1	217	12.7
0.36	1.19	0.43	0.82	1650 AC, 1250 T	95,200	53,100	27.0	55.0	179	16.4
0.36	1.19	0.43	0.82	1650 AC, 1550 WQ, 600 T	217,000	193,000	5.0	7.5	429	...
0.36	1.19	0.43	0.82	1650 AC, 1550 WQ, 800 T	165,700	150,100	11.5	31.3	357	6.5
0.36	1.19	0.43	0.82	1650 AC, 1550 WQ, 1000 T	138,500	122,700	17.0	41.5	285	10.9
0.36	1.19	0.43	0.82	1650 AC, 1550 WQ, 1200 T	110,200	89,400	20.0	52.2	...	15.0
0.36	1.19	0.43	0.82	1650 AC, 1550 WQ, 1275 T	99,100	77,500	27.5	59.5	...	27.7
0.33	1.13	0.53	0.88	1775 AC, 1575 AC, 1275 T	89,850	59,400	30.5	60.3	174	...
0.32	1.14	0.35	0.70	1600 AC, 1250 T	98,600	63,600	23.5	46.0	187	...
0.32	1.14	0.35	0.70	1650 WQ, 1250 T	104,500	83,000	24.0	57.3	...	...
0.30	1.06	0.45	0.67	1650 AC, 1550 WQ, 600 T	157,200	144,500	11.0	29.2	388	...
0.30	1.06	0.45	0.67	1650 AC, 1550 WQ, 1300 T	81,800	58,650	33.0	66.5	179	...

*AC = Air Cooled; WQ = Water quenched; T = Tempered.
**Keyhole notch.

MANGANESE-CHROMIUM-VANADIUM CAST STEELS

(normally expected properties)

Composition (%) C	Mn	Cr	Si	V	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Izod Impact (ft-lb)
0.25	1.20	0.52	0.47	0.17	1650 AC, 1200 T	107,000	85,000	23.0	50.0	....
0.32	1.14	0.47	0.68	0.20	1650 AC, 1200 T	97,000	71,000	28.0	60.3	....
0.32	1.51	0.47	0.29	0.16	1700 AC, 1525 AC, 1275 T	89,250	70,250	26.5	50.0	56.0
0.42	1.45	0.38	0.80	0.16	1650 AC, 1150 AC	116,000	74,000	18.5	42.5	....
					1650 AC, 1450 AC	108,000	62,000	20.0	47.2	....
					1650 OQ, 1150 AC	115,000	74,000	21.0	41.0	....
					1650 OQ, 1450 AC	105,000	73,000	25.5	48.9	....
0.44	1.48	0.61	0.47	0.10	Double Norm. & Temp.	119,250	76,600	25.0	56.2	34.5
0.36	1.29	1.28	0.44	0.11	Double Norm. & Temp.	113,900	78,800	25.0	62.6	39.0
0.34	1.51	0.47	0.29	0.16	1650 FC	104,100	62,500	22.5	48.0	11.0
					1650 AC, 1200 T	112,250	86,750	16.0	41.5	....
					1650 AC, 1650 AC, 1200 T	98,000	72,000	25.0	54.0	44.0
					1700 AC, 1525 AC, 1275 T	89,250	70,270	26.5	50.0	56.0

* AC = Air cooled; FC = Furnace cooled; OQ = Oil quenched; T = Tempered.

WATER-QUENCHED MANGANESE-VANADIUM CAST STEEL

(0.32 C, 1.60 Mn, 0.40 Si, 0.10 V)

(test values, normalized 1650 F, water-quenched 1500, tempered as shown)

Tempering Temperature (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Izod Impact (ft-lb)
700	189,000	166,000	7	20	8
900	148,000	137,000	14	38	16
1100	129,000	120,000	18	43	20
1200	110,000	100,000	21	47	36

MANGANESE-MOLYBDENUM CAST STEELS

(normally expected properties)

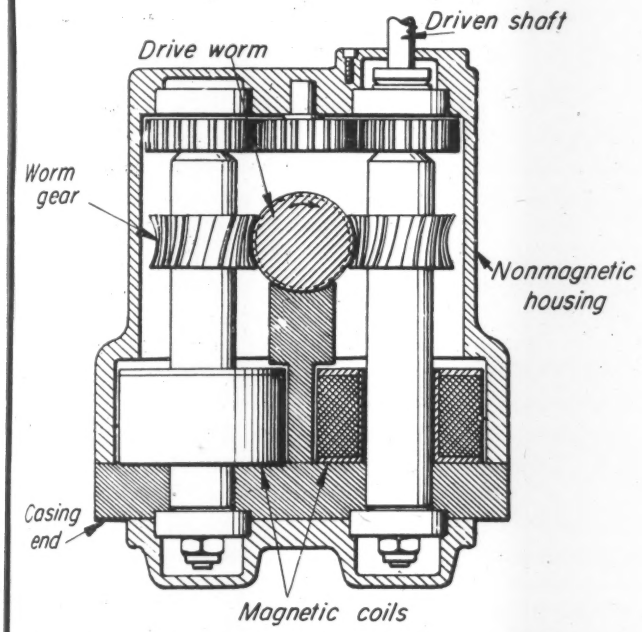
Composition (%) C	Mn	Si	Mo	Heat Treatment* (deg F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.	Charpy Impact (ft-lb)
0.20	1.11	...	0.33	1250 NT	81,500	58,700	27.0	55.0	165	...
0.24	1.32	...	0.39	1250 NT	86,800	62,500	25.5	51.7	172	...
0.28	1.29	...	0.30	1250 NT	88,500	63,750	26.0	55.2	176	...
0.30	1.25	...	0.35	1250 NT	92,500	65,300	25.2	52.5	187	...
0.32	1.15	...	0.34	1250 NT	93,800	65,400	24.1	49.5	192	...
0.34	1.35	...	0.32	1250 NT	89,500	60,000	24.0	50.0	...	...
0.36	1.33	...	0.35	1250 NT	96,000	68,000	23.8	49.5	...	...
0.40	1.60	...	0.35	1250 NT	98,200	69,500	23.0	49.0	208	...
0.28	1.29	0.46	0.30	As Cast	97,000	72,500	6.0	11.5	223	16.1
0.28	1.29	0.46	0.30	1700 Full Annealed	91,000	62,000	21.5	34.4	187	19.8
0.28	1.29	0.46	0.30	1700 AC	111,500	80,000	20.0	30.8	228	23.7
0.28	1.29	0.46	0.30	1700 AC, 1500 AC	112,250	81,000	20.5	28.8	228	25.3
0.28	1.29	0.46	0.30	1700 AC, 1500 AC, 1200 T	84,500	64,750	28.0	60.5	179	45.3
0.28	1.29	0.46	0.30	1700 AC, 1500 WQ, 1050 T	133,750	117,250	17.5	48.0	302	35.9
0.28	1.29	0.46	0.30	1700 AC, 1500 WQ, 1200 T	100,000	83,750	23.5	57.0	212	51.4
0.28	1.29	0.46	0.30	1700 AC, 1500 WQ, 1300 T	87,250	62,500	27.5	62.5	187	57.0

*NT=Normalized and Tempered; AC=Air Cooled; WQ=Water quenched; T=Tempered.

Noteworthy Patents

Magnetic Reversible Gear Drive

PROVIDING a most unique method for coupling a worm and gear drive and for selecting direction of rotation, the mechanism in the accompanying illustration is



Magnetic flux path created through worm and gear maintains a minimum air gap forcing teeth to remain in registry

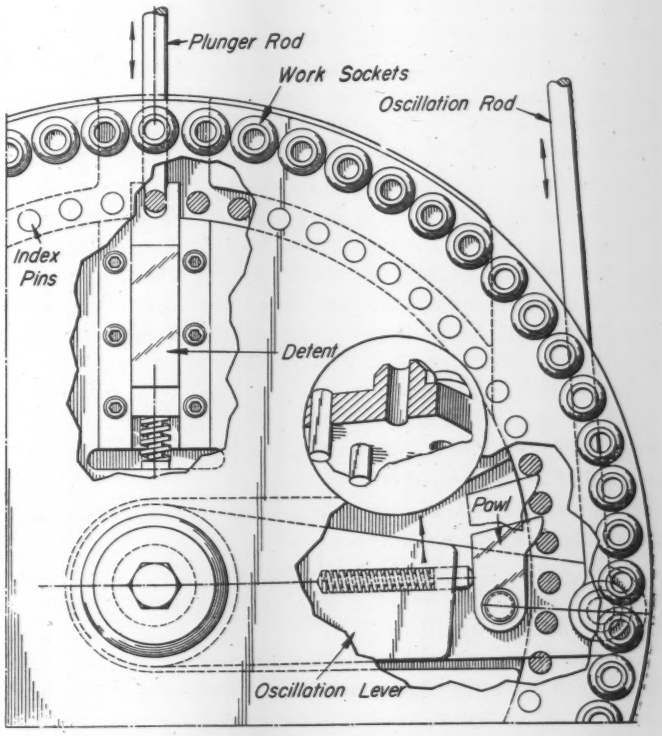
covered by patent 2,373,663. Recently assigned to the Woodward Governor Co. the patent on this reversible drive outlines the utilization of magnetic flux as the linking medium for the gearing rather than actual tooth contact.

Teeth of worm gears used are of the same pitch and adjacent to but actually out of contact with the concave matching worm. Both the drive worm and worm gears as well as the worm gear shafts, casing end and center projection are made of a highly magnetizable material while the remainder of the unit is nonmagnetic. Magnetic flux induced by one of two magnetic coils completes a path linking the adjacent worm gear with the drive worm. Flux so induced tends to maintain a minimum air gap between the worm and gear so that the worm gear teeth are forced to follow or remain in registry with the thread of the worm. Any tendency in either flux path to by-pass through the worm to the opposite inactive worm gear and reduce the power transmitted is obviated by a partial energization of the inactive gear winding. This winding is powered at a low potential with a polarity such that it effectively balances out or neutralizes any leakage flux that may be present. A rheostat is included in the circuit for balancing.

Accurate, Inexpensive Indexing

A NOVEL indexing mechanism combining relative simplicity and low cost with a high degree of precision is shown in the accompanying illustration. Recently assigned to the Pennsylvania Manufacturing Co., the design is covered by patent 2,376,137.

Work sockets of any variety and number in a main index plate are arranged in accurate radial alignment with a like number of index pins which extend below the plate. Slotted to engage these index pins below the plate is an accurately fitted detent, spring loaded and arranged to be released by pressure from a plunger rod. Indexing of the plate is effected by means of an oscillation lever on which is mounted a spring-actuated pawl arranged to engage the same index pins. Angular positioning of the pins and



Pins in exact radial alignment with the work sockets in index table are used both for advancing and locating

work sockets has no effect on the accuracy of indexing.

In operation, a pair of cams first releases the detent by means of a plunger rod and then advances the table one station with the pawl lever. The cams controlling this action and table dwell are designed so as to synchronize the movement of the pawl to advance the table only after the detent has been released, the detent again engaging an index pin before the oscillation lever and pawl return to initial position.

Design Abstracts

Jet Propulsion for Transports

TURBO-JET engines for driving propellers will appear shortly on all airplanes designed to travel at speeds under 500 miles an hour and at altitudes under, say, 30,000 feet. A gas turbine, somewhat smaller in diameter and lighter than the 2200-hp engine on the Constellation transport plane, will develop from 6000 to 7000 hp. There will be a slight amount of boost from the exhaust jet, but most of the energy of the hot gases will be absorbed by the turbine connected to the propeller by a reduction gear.

For higher speeds, say from 500 to 1500 miles an hour, there will be pure jet engines without propellers. These will be less efficient at the lower altitudes, but at 25,000 feet or over, running at full power, they will compare favorably in efficiency with conventional engines.

The future transport will be of the pure jet type. It can be as large as is necessary to meet the demands of the traveling public, for there will be plenty of power available to fly this ship. The cabin will be pressurized for flight above 50,000 feet. Traveling above the speed of sound, 10 miles above the earth, there will be no noise, no sense of speed. Weather will make no difference at all since the plane will fly over storms. Radio navigational aids, already well developed, will permit landing with perfect confidence on an airport that is zeroed in by fog or snow.

The transport just described will be able to use any airport that is large enough to handle our big bombers today. It is likely that current research on wing flaps and other high-lift devices will permit even lower landing speeds than today's ships possess. The chances are that each of its power units will supply as much as 10,000 hp. When we consider that the Lockheed Constellation, with a gross weight of approximately 100,000 pounds, has a total power output of less than 10,000 hp, we can visualize what it means to have 10,000 hp available for each of as many power units as we wish to use.

This airplane will not be built immediately. The industry needs a few years to get acquainted with jet propulsion, and such a plane is 10 to 15 years away.

Planes traveling within the earth's atmosphere will not be able to fly faster than about 1500 miles an hour because the friction of the air will heat them above the point where cooling is practical. At 1500 miles an hour a temperature rise of some 400 degrees would be experienced. To avoid that, rocket airplanes will go very much higher where there is practically no air to create drag or cause excessive heating of the ship. Flying outside the earth's atmosphere, there is theoretically no limit to the speeds that can be attained. If we have somewhere to go fast, there is no reason why we won't be able to travel 10,000, yes, 100,000 miles an hour. Mind you, we shall have to have some reason for going that fast. But I know of nothing now that will prevent our doing so if we choose.

There is nothing from the medical standpoint that will prevent our traveling at these high speeds. But acceleration and deceleration are different matters. These forces must be held to a value that the human body can stand, which is about 3g for an indefinite period. A rocket accelerating at 3g outside the earth's atmosphere would attain a speed of 10,000 miles an hour in less than five minutes. So these speeds may not be so fantastic as they seem at first.—*From a recent address by Hall L. Hibbard, Vice President and Chief Engineer, Lockheed Aircraft Corp., in Los Angeles.*

Creative Engineering in the U. S.

OUR ENTIRE social structure has been altered during the last century by inventors, who are the constructive builders of our civilization. These inventors opened new frontiers and opportunities for abundant life not by depriving people and nations of their property rights through robbery, trickery and offensive warfare, but by creating new wealth in the form of new materials, new processes, new devices, new industries, more economical manufacturing methods, and new products.

The art of inventiveness may be the result of logical scientific thought and tireless experimentation or it may depend on intuitive insight. Intuition appears to be the innate ability of some inventors. The inventor at times finds a correct solution or creates a working mechanism based on laws not known at the time the discovery was made. Intuitively, some inventors are able to foresee correctly the future and its requirements and to arrange and direct their efforts accordingly. Men of genius have, upon occasion, created correct theories or made true discoveries long before enough tangible evidence had become available to justify their assumptions. Intuition on the part of Leonardo da Vinci enabled him to show in his paintings and writings certain details in accord with scientific data and discoveries which were unknown in his time. To encourage creative endeavor, inclusive emphasis upon logical thinking should not be carried to such a degree as to neglect the use of intuition. Insight is the father of invention far more than necessity is its mother.

Inventors can be made and creativeness can be developed by proper education, training and environment. Those who invent differ from others not in the kind of experience, but in their attitude toward it. The inventor is constantly curious about the reasons why and how a device works and has a definite interest in improving it. Inventiveness requires, in addition to scientific knowledge, good reasoning power, constructive discontent with things as they are, recreative imagination, diversified experience, curiosity, resourcefulness, open-mindedness, industry, perseverance, and optimism.

While the inventor must be equipped with scientific knowledge—an indispensable tool in research and other creative endeavor—he must continuously protect himself against the encroachment of custom and habit and must have the capacity to construct bold, effective, and varied

concepts out of the clues which lie concealed in scientific and technological problems.

Environment and the form of government account for the fact that Europeans—not nearly as inventive in Europe as the Americans—have produced in this country a Steinmetz, a Pupin, a Baekeland, and a Sikorski. These men of genius would probably never have achieved the inventions which America brought forth from them had they remained in their native environment. Our patent system, stimulating the creative talents of our people, is largely responsible for the industrial supremacy of America and for the high standards of living of its people. It guarantees to inventors and to those who invest in inventions far greater protection than that of any other country, and under it the best and the largest body of inventions in the world has been developed.

Another factor which has contributed to creativeness in this country is that in America, more than in any other country in the world, along with the enterprise to create, there is a willingness to discard a satisfactory present in order to create a better future. Rapid obsolescence engenders invention.—*From a paper by A. A. Potter, Dean of Engineering, Purdue University, and Executive Director, National Patent Planning Commission, presented at the 1944 annual meeting of ASME.*

Applying Silver Bearings

SILVER as a bearing material has shown excellent capacity and fatigue resistance. When properly prepared and bonded to the bearing backing its resistance to fatigue is greater than that of any other known metal. Factors which affect performance are summarized as follows:

1. PURITY AND HARDNESS: The silver should be as pure as possible. For overall applications it should not exceed a hardness of 45 Vickers, (15 Kg), or a Meyer ultimate hardness number of 46.7.

2. BONDING: For resistance to fatigue there must be a good bond between the silver and the bearing backing. In present-day practices both the electrodeposited type and the thermally bonded type have been found to produce satisfactory results.

3. HEAT-TREATMENT: It is preferable to heat-treat silver bearings in a hydrogen-rich atmosphere. Continued heating in air has shown a detrimental effect on the bond, due to the oxygen penetration of the silver. Silver must also be oxygen-free to be heated in hydrogen-rich atmosphere.

4. SILVER-STEEL STRIP: Using thermally bonded and rolled type of silver strip:

(a) The silver-steel bond is automatically tested in the bearing manufacturing process.

(b) After circle forming the steel backs can be heat treated for greater strength.

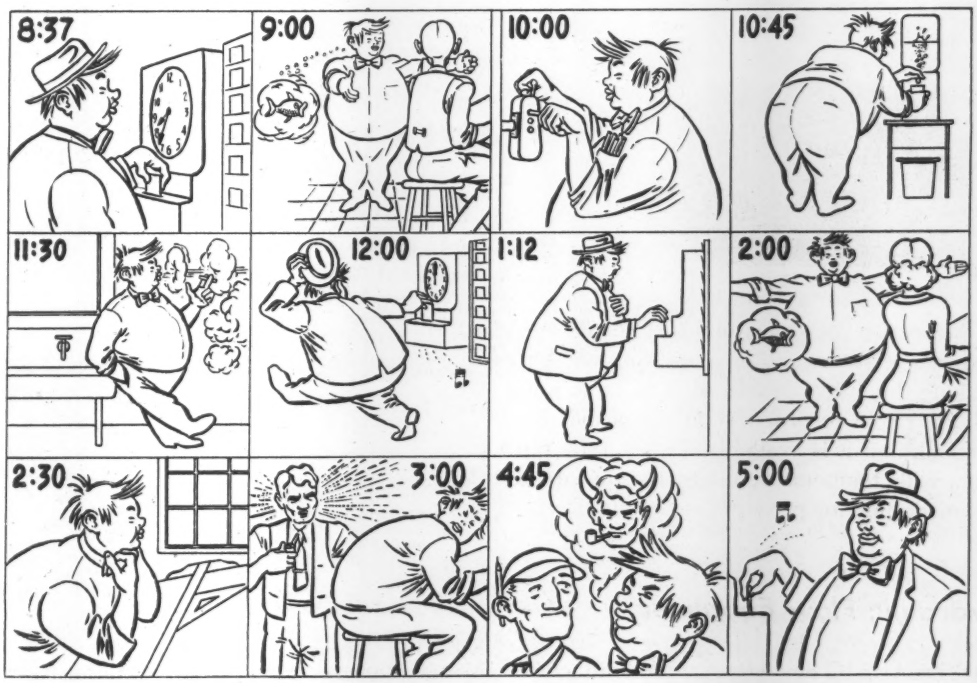
(c) Bearings for aluminum crankcases can be made with stainless steel or bronze backings, which give lower thermal expansion differentials. Thin-wall bearings may then be used, which can be produced at lower costs because automotive type of tooling can be utilized effectively.

5. INDENTING:

(a) By indenting the bearing surface a final visual check on the bond between the silver and the backing metal can be obtained.

(b) By surface indenting and then filling, or partially filling the indentations with lead alloy, the performance of silver bearings can be greatly improved.

(c) By using the smallest practical indentations improved fatigue resistance and bearing performance can be obtained.—*From a paper by E. B. Etchells and A. F. Underwood, General Motors Research Laboratories, presented at a recent meeting of the Detroit Section of SAE.*



Briskbottom's Day

NEW PARTS AND MATERIALS

Silicone Insulating Varnish

FOR IMPREGNATING electrical equipment, Dow Corning Corp., P. O. Box 592, Midland, Mich., is offering its DC 996 heat-stable, waterproof silicone varnish. Its application in electrical equipment provides protection against failure due to sustained overloads; increased protection against excessive moisture even after prolonged exposure to elevated temperatures; increased power output per unit weight; elimination of fire hazards resulting from failure of insulation; and higher permissible operating and ambient temperatures. Equipment can be baked fully assembled without damaging commutators or slip rings. Temperature required to cure the varnish does not affect shellac-bonded mica or core plating. It cures at temperatures comparable to those used at the present time for organic insulating varnishes and is applied in the same manner. The varnish is recommended for temperatures up to 175 C (347 F). For higher temperatures DC 993 should be used.

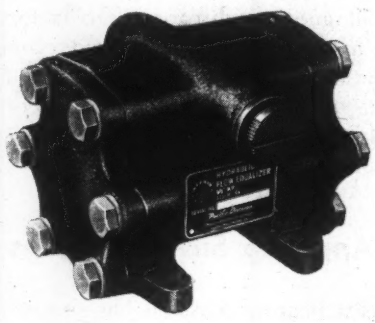
Records Pressure on Potentiometer

PRESSURE TRANSMISSION problems may be simplified by a pressure transmitter announced by Trimount Instrument Co., 37 W. Van Buren St., Chicago 5. The transmitter records pressure on any continuous balance

potentiometer. More than one pressure can be recorded on the same instrument by means of a special switching arrangement, making the unit valuable where a large number of pressures are to be recorded simultaneously. Size and weight are small, and it is available for any type pipe fittings. Having a wide temperature range, the transmitter is used for gases or liquids for pressures up to 1000 psi.

Hydraulic Flow Equalizer

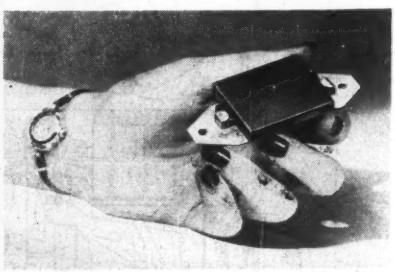
WITH THE HYDRAULIC flow equalizer, manufactured by the Pacific Division of Bendix Aviation Corp., North Hollywood, Calif., balanced flow in either direction to two unequally loaded hydraulic actuating cylinders is possible. Necessity for mechanical interconnection or for two pumps is eliminated in the equalizer. It is only necessary to replace the "T" in the pressure line from the control valve with the unit. An installation such as this in a double-



acting system will accurately equalize flow from one line into two branch lines and, in the reverse flow, from two branch lines into one line. Metering is automatic, the unit incorporating a balanced metering piston which does not depend upon outside mechanical action as the proportioning agent. With simple modification the equalizer is also available as a proportioner, splitting flow into two lines with predetermined greater flows in one line than the other. Operated in the reverse direction, it will combine two such uneven flows, maintaining the specified proportion between the two lines.

Light-Duty Vibration Mount

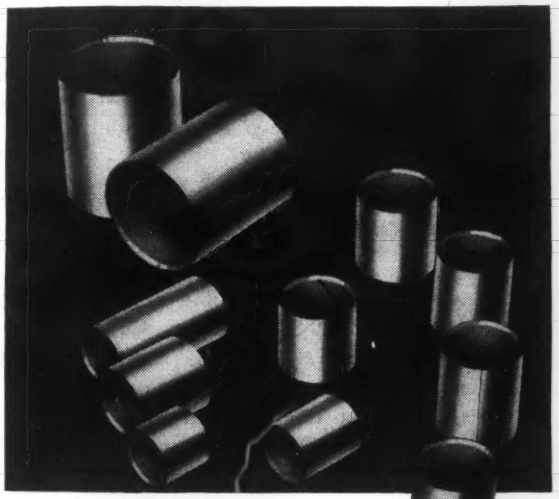
FOR HANDLING LOADS as low as one pound, a new light-duty vibration mount has been announced by Hamilton Kent Mfg. Co., Kent, O. The Rexon mounts are designed to eliminate disturbing vibration and noise from



small motors, typewriters, business machines, household appliances, small power tools, etc., or to isolate delicate instruments, etc., from external vibration. A radical de-

JOHNSON BRONZE
SLEEVE BEARING HEADQUARTERS

No Reconversion *problem*



SHEET METAL
Rolled Bronze. Bronze On Steel. Babbitt On Steel.

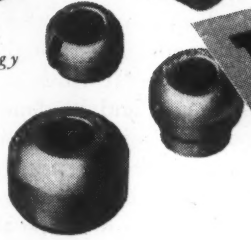
Johnson Bronze is ready to supply your peace time bearing needs. We had no reconversion problem. The change from war production to peace time operation was made *over night.* And we have much more to offer Industrial America. Our facilities have been increased . . . our equipment is the finest obtainable . . . we have added greatly to our skill and experience . . . and we are the *only* bearing manufacturer that makes *every* type of Sleeve Bearing. Why not consult with Johnson Bronze now? Let us help you solve your bearing problems . . . help you get an early start for your post-war market.

JOHNSON BRONZE CO.
525 S. MILL ST. NEW CASTLE, PA.

CAST BRONZE
Plain or Graphited

BABBITT LINED
Bronze or Steel Backing

LEDALOYL
Power Metallurgy



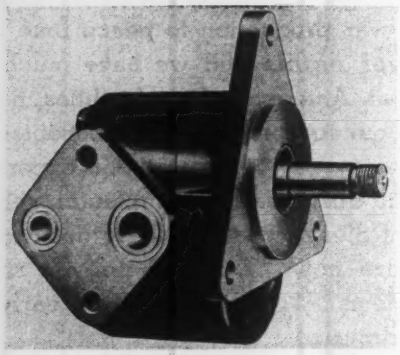
JOHNSON BRONZE
SLEEVE BEARING HEADQUARTERS

BRANCHES IN 18 INDUSTRIAL CENTERS

parture from conventional practice, the new principle of design combines the high vibration dampening properties of rubber loaded-in-shear, with safety, durability and ease of installation of a simple compression mount. No overloading of the shear elements is possible with the new mount.

Gear Type Hydraulic Pump

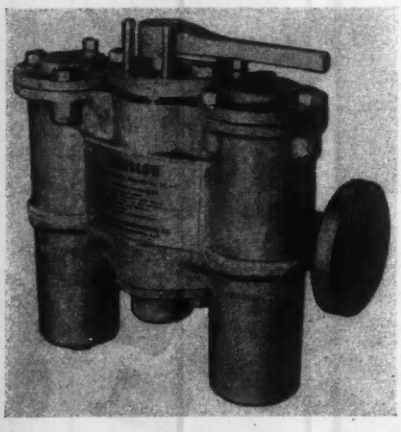
GENERAL-PURPOSE HYDRAULIC pumps, just developed by PESCO Products Co., 11610 Euclid Ave., Cleveland 6, have an unusually high volumetric efficiency. Calibrations show efficiencies of 95 per cent and better at



3000 rpm under pressure of 1500 psi. Suitable for universal application where hydraulic power is utilized, the gear type pump has triangular mounting pad, SAE magneto flange, or is readily adaptable to other design mounting for special installations. Capacity rating is 3.5 gallons per minute at 1500 rpm or 7 gallons per minute at 3000 rpm. Weight is 4.4 pounds.

Powerful Magnetic Strainer

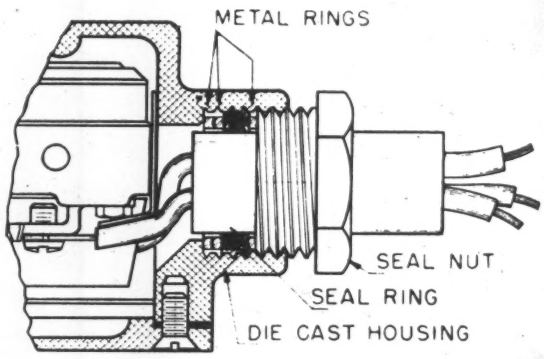
AN IMPROVED MAGNETIC strainer, recently developed by Winslow Engineering Co., Oakland, Calif., combines the effect of powerful permanent magnets with



fine screening to remove filings and metal particles from oil systems or other liquids. According to the company, its use in many varied fields has demonstrated that with slight adaptations the basic design is applicable to a variety of liquid filtration problems. Two cylindrical baskets consist of a main body of perforated steel within which are fine wire mesh linings. Magnets are suspended within these baskets. The one-piece body, of either cast bronze or iron, incorporates the manifold, strainers, inlet and outlet connections, by-pass valves, pressure regulator and main control valve. The quick-acting hand-operated three-way control valve permits change of flow from one strainer element to the other, or through both simultaneously. Flow is maintained through either one or both strainers regardless of position of the valve control lever. With flow directed through one basket, the other basket and magnet assembly can be removed for cleaning as one unit. Magnet assembly can easily be detached from the basket for additional cleaning or inspection, if necessary. Outgoing pressure may be regulated by a valve adjacent to the three-way valve. Model 200-MS-1 duplex strainer handles 15 gallons per minute, while a larger model handles 40.

Sealed Cable Offered

QUICK AND EFFICIENT sealing of Type "S" rubber power-supply cord, 2 or 3 conductor, No. 14 gage, into sealed die-cast enclosed switches has been developed by Micro Switch Div. of First Industrial Corp., Freeport, Ill. As illustrated, this consists of metal rings on either side of a rubber seal ring which expands under pressure of the seal nut, giving a tight seal against dust and moisture. The



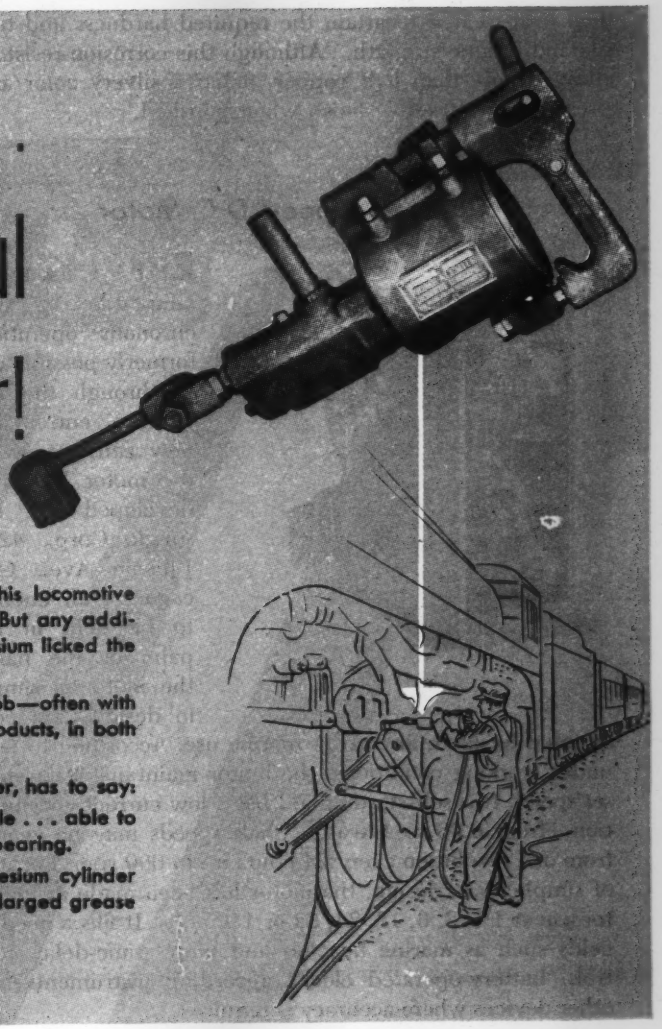
new method of sealing is in line with the company's policy of supplying its thumb-size plastic-enclosed switch with actuators and housings to meet a wide range of industrial switching problems.

Hardenable Manganese Alloy

DESIGNERS OF severely stressed parts will be especially interested in the new manganese alloy, No. 720, announced by Driver-Harris Co., Harrison, N. J., because of its high ratio of yield strength and proportional limit of tensile strength. This soft, ductile metal which can be hot or cold-formed into intricate shapes and hardened to a high degree by a low-temperature aging treatment, has a wide range of useful properties offering possibilities in design of springs, diaphragms, and other parts in which design requirements make it desirable to shape the part first and

magnesium made it possible . . .

bigger, more powerful —yet 18% lighter!



He was up against a real problem, the manufacturer of this locomotive grease gun! His product needed more power, strength, size. But any additional weight would have been a prohibitive penalty. Magnesium licked the problem—and brought the weight *down* 18%!

It's a product story that illustrates the kind of weight-saving job—often with *added strength*—that magnesium is doing today for many products, in both consumer and industrial fields.

Here's what The Prime Manufacturing Company, the producer, has to say:

"We now have a cylinder body much larger than the old style . . . able to develop 17,000 pounds pressure per square inch at the bearing.

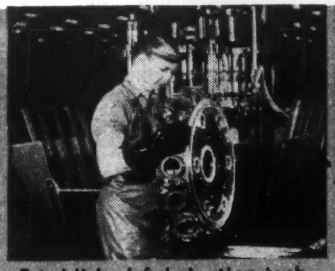
"We use not only a magnesium cylinder body but a magnesium cylinder body cap and a magnesium handle. The total weight of the enlarged grease gun is now twenty-six pounds—six pounds lighter . . ."

Ready . . . to make products move!

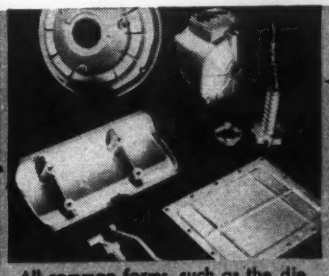
MAGNESIUM

LIGHTEST OF ALL STRUCTURAL METALS

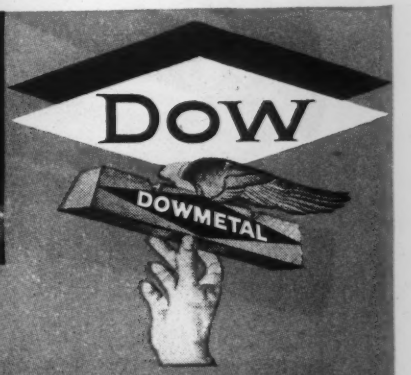
Magnesium production, from both brine wells and sea water, is abundant. Dow is the pioneer and foremost producer in the field.



Established fabrication techniques, backed by 29 years of Dow experience, are used by plants throughout the nation.



All common forms, such as the die castings shown here, are standard production items in the fabrication of magnesium parts and products.

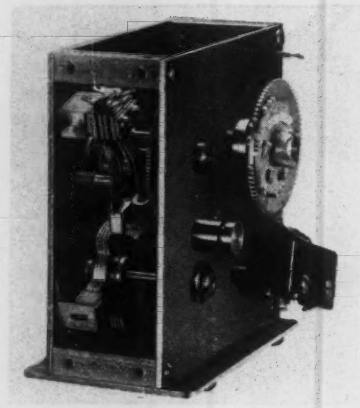


MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

then heat-treat it to attain the required hardness and tensile and fatigue strength. Although this corrosion-resistant alloy is more than half copper, it has a silvery color and presents an attractive finish when polished.

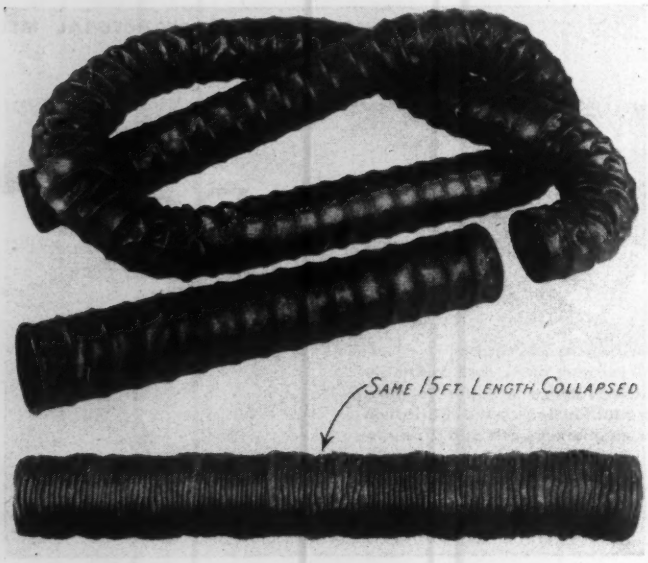
Constant Speed D-C Motor



ESPECIALLY adaptable to synchronous operation, formerly possible only through the use of a-c current, a new constant speed d-c motor has been developed by the Amglo Corp., 4234 Lincoln Ave., Chicago. Small enough to be held in the palm of the hand, the motor is simple in design, and constructed for land, aircraft or marine use. According to tests under working conditions, the motor maintains a constant set speed. It is self-starting and has a low current consumption (from 0.06 to 1 watt). Shaft speeds may be geared from one revolution every 24 hours up to 600 rpm. Because of simplicity in design, the motor has been made available for use at 1½, 3, 6, 12, 24, 32 or 110 volts. It fills a need in fields such as marine beacons and buoys time-delay controls, battery-operated clocks, recording instruments and other devices where accuracy is required.

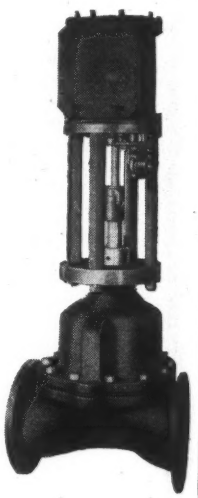
Flexible Ventilating Hose

TRADENAMED Portovent, a new type ventilating hose has been developed by American Ventilating Hose Co., 15 Park Row, New York, to supplement its more rigid spiral wire reinforced hose and a nonreinforced one. It meets the need for metal-reinforced, lightweight, large-diameter ducts which can be compressed into small space for transportation and yet stay open around sharp bends when installed. Particularly suitable for use with portable tank ventilators, air conditioning and heating and cooling units, the hose is of sectional construction, allowing the assembly of any desired length from 2½-foot sections. These are readily coupled and uncoupled with the hand, and form a tight joint which will not be broken by jerks or pulls encountered in service. Special attachments for coupling to blowers or other air-handling apparatus are provided, and these fittings couple interchangeably with either end of any section. Reinforcement consisting of rings spaced from 2 to 5 inches apart, varying according to the diameter of the hose, are held in place around their entire circumference by a synthetic rubber-base compound which also covers the inside and outside surface of the hose. The hose is offered in sizes from 5 to 24 inches in diameter. Compression for packing is 6 to 1 overall, and can be still greater if application is for light service.



Air-Operated Valve

AIR-OPERATED VALVES are now available from Hills-McCanna, 3025 North Western Ave., Chicago 18, in sizes ranging from 4 to 12 inches. Special controls, together with an air-actuated piston mounted on the valve, operate it. These special controls, of simple open-and-shut type operation, provide opposed-air operation for smooth throttling over a range wide enough for easy instrumentation. An auxiliary air tank provides shut-off in case of failure of the main air supply. The new valve will be of particular interest to the pulp, paper, chemical, and other bulk process fields.



Plastic Foam Buoyant Material

KNOWN AS Flotofoam, the buoyant material produced by United States Rubber Co., Rockefeller Center, New York, and used in armored tanks, is now being offered for such peacetime applications as insulation for automobiles, trains, and airplanes. It weighs less than a pound and a half per cubic foot, and can be made to weigh as little as three-quarters of a pound per cubic foot.

Hermetically Sealed Resistors

HERMETICALLY SEALED precision resistors, built by Daven Co., 191 Central Ave., Newark 4, N. J., originally for use in Army and Navy equipment, are being offered now for use in equipment where extremes of humidity and temperature are present. Resistor elements are mounted in a drawn brass case, and soldered connections are brought

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STEEL CORPORATION
PITTSBURGH 30, PENNSYLVANIA

SPECIAL COLD DRAWN SHAPES SAVE MACHINING

out through fused-glass seals. Interconnecting wiring and resistors are braced to withstand vibration and shock. The drawn brass cover is also soldered into fixed position. A unique mounting bracket permits vertical, inverted or horizontal mounting. Dimensions of the resistors are 1 9/16 x 1½ x ⅞ inches deep. Terminal height is 9/16-inch. The resistors may be furnished in any range, with a maximum of 1,600,000 ohms, depending on the type of resistance wire employed. They are available with two terminals at one end or terminals at each end. A single four terminal unit is designed to take up to four separate spool type resistors of different values and accuracies.

T-Type Oil Clarifier

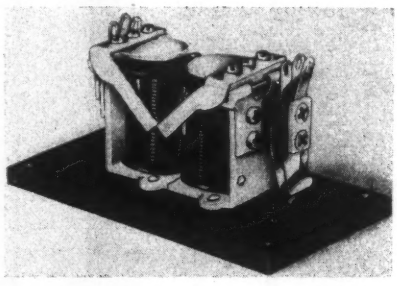
SAID TO REMOVE 95 to 98 per cent of chips, abrasives and other solid contamination from oils and coolants, the new oil clarifier, introduced by Honan - Crane Corp., 565 Wabash Ave., Lebanon, Ind., utilizes multiple tubes covered with closely woven cotton filter tubing. Known as the T-type clarifier, dirty oil enters the unit at the bottom, surrounds the filter tubes, passes through the cotton cloth and filter screens and rises to the clean oil outlet, assuring a constant flow of clean oil or coolant. Cycle of operation is automatic with exception of short periods required for removal of accumulated abrasives from the cotton tubing. The clarifier is available in two models: The T-4 model is designed to serve a single machine, connecting direct to the oil system; and Model T-8 is equipped with its own motor-driven pump and operates independently of the equipment's system, being connected with the sump. This latter type is capable of handling oil or coolants from two or more machines.

Two-Way Stretch Decals

DECALCOMANIAS with a "two-way stretch", banned from civilian production during the war, are now available in unlimited quantities for all uses from The Meyercord Co., 5323 West Lake St., Chicago. Known as "Elasti-Cals", they are made of stretchable material and applied to rubber and other elastic surfaces for use as nameplates, trademarks and colorful decorations.

Small Latching Relays

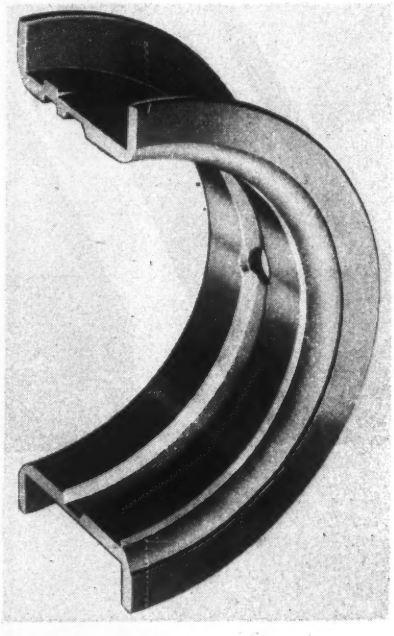
OFFERED BY Cook Electric Co., 2700 Southport Ave., Chicago 14, new, small latching relays, known as Latching Aerotrols, combine two Aerotrol "400" series relays with an interlocking armature. This design makes possible the combining of any two Aerotrols of similar or different types into a latching relay. They can be supplied in either single or double pile-ups and with standard spring pile-up



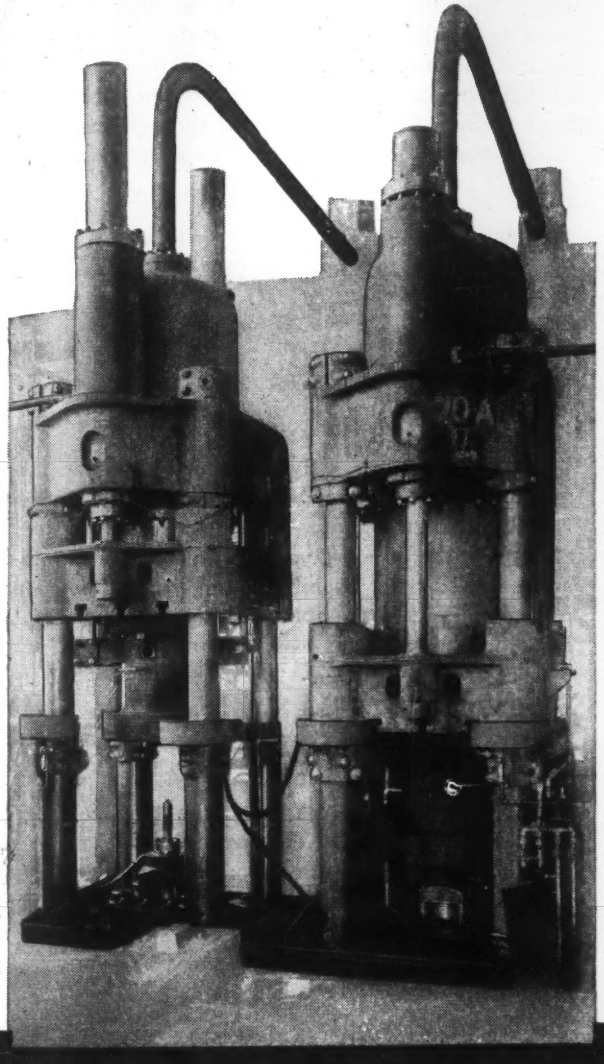
formations and combinations. Mounting arrangements are to specification. Supplied for either alternating or direct-current operation with maximum voltage of 125 volts direct current or 120 volts, 60 cycle alternating current, the relays are 1 9/16 inches in height, 2⅞ inches in length, and 13/16-inch in width.

Powder-Metal Engine Bearings

ENGINE BEARINGS used in war equipment, are now being produced in quantities by Moraine Products Division, General Motors Corp., Dayton, O., for motor cars and trucks. These Durex-100 bearings, made especially for the main and connecting rods of internal combustion



engines, will enable automotive engineers to design engines operating at high unit bearing pressures. Produced by powder metallurgy the bearing is a steel-backed lead base babbitt lined bearing. There is an additional intermediate layer of a metallic sponge-like structure, or matrix, copper brazed to the steel back into which the babbitt is cast. The babbitt, developed specifically for this bearing,



IT'S VIM 20 to 1-

COMPRESSION PACKINGS WORE OUT IN ONE WEEK!

VIM Leathers lasted 5 months plus!

Piercing presses for 105 mm. H. E. shell forgings, exerting a pressure of 1260 PSI, had been equipped with ordinary compression packings. Each week the packings had to be renewed—with down-time loss and high upkeep.

The contractor changed to VIM Leather "V" Packings recommended by our hydraulic engineers. The first press so packed ran *five months* without a packing failure; had not production been halted on V-J Day, it might still have been running.

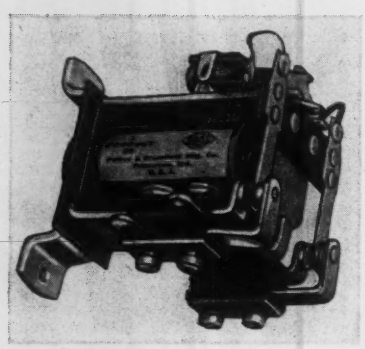
Meanwhile all other presses in that huge installation were being changed over to VIM Leather Packings, which were providing long, trouble-free service.

Twenty times the life of other type packings is not too unusual for VIM. These moulded leathers, designed right, made right, and engineered for the job, can well be the answer to *your* packing problem. Write E. F. HOUGHTON & CO., 303 W. Lehigh Ave., Philadelphia 33, Pa.

HOUGHTON'S *Engineered* **VIM** *Leather Packings*

is a corrosion-resistant high-lead alloy. Some of the advantages of this bearing are high-conformability, high imbedability, high resistance to fatigue cracking, high resistance to corrosion, and a higher melting point.

Plate Circuit Relays



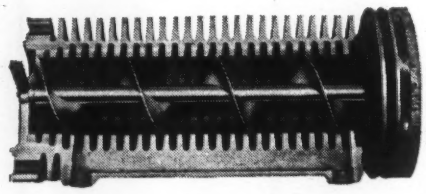
STANDARD TYPE plate circuit relays known as the LMR Series have been developed by Potter & Brumfield Mfg. Co. Inc., Princeton, Ind., to meet the demand for a medium cost relay in both single and double-pole contact arrangements. They are built in two sizes: Single-pole relays are 2¼ x 2⅜ x 1⅜ inches, and the double-pole units are 2¼ x 2⅜ x 2⅛ inches. Sturdily constructed with extra large coils to provide good contact pressure at low current values, the relays have a standard adjustment of approximately 0.1-watt for the single-pole type and 0.2-watt for the double pole, although lower values can be obtained if required. This series is available in six contact arrangements: Single pole, double throw; single pole, single throw, normally open or normally closed; double pole, double throw; double pole, single throw, normally open or normally closed.

Steel Blind Fastener

ORIGINALLY MADE only in aluminum, and then brass, the Rivnut is now being offered in steel by the manufacturer, The B. F. Goodrich Co., Akron, O. This one-piece internally threaded and counterbored tubular rivet which can be upset or headed from one side and used as a blind rivet, nut plate for attachment, or both, is available in threads of 6-32, 8-32, 10-32, 12-24; and ¼-inch—20 thread and ⅜-inch—18 thread. Special sizes are also furnished on order. An additional head style, the brazier head, has also been introduced particularly for the trailer and bus industry.

Heat Exchanger

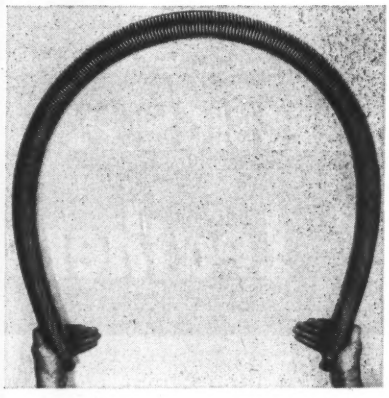
DEVELOPMENT OF a new heat exchanger has been announced by The Bird-White Co., 3119 West Lake St., Chicago 12. It is based on the principle of heat transfer for air and gas lines and offers, as a by-product, external heating applications and purification by centrifugal action. As an after-cooler, the unit is recommended for installation at the compressor discharge point. Having a liberal supply of external and internal cooling fins, the exchanger features a multiple action helicoid flighting. The flighting is revolved at high speeds by the velocity of the element, forcing the air or gas outward against the internal cooling fins. These fins rapidly absorb the heat generated in compression, and dissipate the heat to the outside atmosphere through external cooling fins, lowering the element to room temperature in the



length of the unit. By this cooling action, vaporized moisture and oil suspended in the element condenses and is entrained in a sump, assuring a moisture-free, cooled element at the discharge point. Available for both flanged and screwed-type assemblies, for either manual or automatic draining of the sump, the exchangers may be used in tandem installations to any required length.

Flexible Stainless Hose

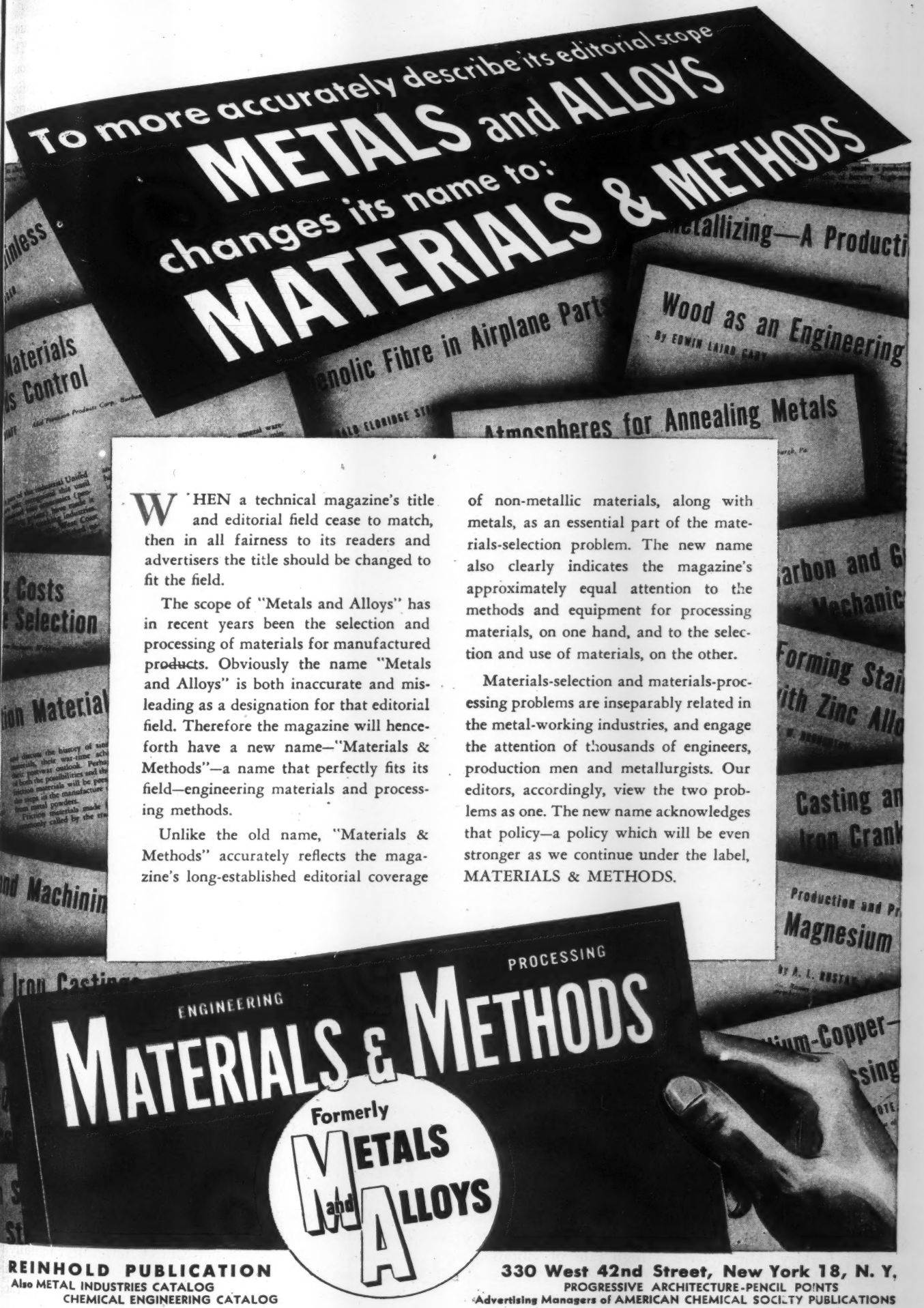
MANUFACTURED BY the Carpenter Steel Co., Welded Alloy Tube Division, Kenilworth, N. J., flexible stainless steel hose is being produced for applications where flexible connections are required between movable parts, or where



vibrations are set up between two rigidly held units. Made from stainless steel tubing of various analyses, the hose can also be used for flexible steam connections, flexible conduits for wiring, and intricate connections on lines carrying corrosive fluids. Additional information as well as the name of the fabricator of this type of hose may be obtained from The Carpenter Steel Co., producer of the stainless steel tubing.

New Type Check Valves

HAVING NO POPPETS, disks or other metal working parts, a new Permatite valve has been designed by Harman Equipment Co., 937 Santa Fe Ave., Los Angeles, for



WHEN a technical magazine's title and editorial field cease to match, then in all fairness to its readers and advertisers the title should be changed to fit the field.

The scope of "Metals and Alloys" has in recent years been the selection and processing of materials for manufactured products. Obviously the name "Metals and Alloys" is both inaccurate and misleading as a designation for that editorial field. Therefore the magazine will henceforth have a new name—"Materials & Methods"—a name that perfectly fits its field—engineering materials and processing methods.

Unlike the old name, "Materials & Methods" accurately reflects the magazine's long-established editorial coverage of non-metallic materials, along with metals, as an essential part of the materials-selection problem. The new name also clearly indicates the magazine's approximately equal attention to the methods and equipment for processing materials, on one hand, and to the selection and use of materials, on the other.

Materials-selection and materials-processing problems are inseparably related in the metal-working industries, and engage the attention of thousands of engineers, production men and metallurgists. Our editors, accordingly, view the two problems as one. The new name acknowledges that policy—a policy which will be even stronger as we continue under the label, MATERIALS & METHODS.

A REINHOLD PUBLICATION
Also METAL INDUSTRIES CATALOG
CHEMICAL ENGINEERING CATALOG

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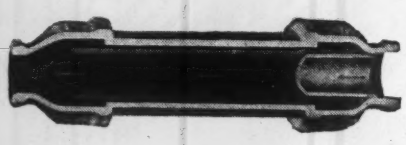
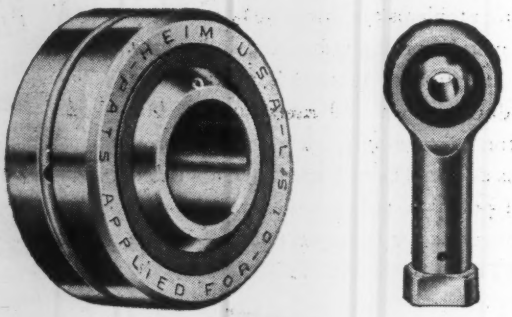
handling air, natural gas, any commercial liquid including petroleum, hot or cold water, and chemicals that will not attack synthetic rubber. The valve may be used as a foot valve, vertical, horizontal or angle valve in any suction or discharge line, also as a mixing valve, pump priming valve or as an air compressor silencer. Back-flow is checked by a synthetic rubber tubing, which opens with



either vacuum or pressure, permitting direct flow, and closes when the flow is stopped. According to the company, immediate deliveries can be made on valves rated at working pressures up to 125 psi in ½, ¾ and 1-inch sizes. Other standard sizes are also available.

Rod End Spherical Bearings

DEVELOPED BY The Heim Co., Fairfield, Conn., spherical bearing and spherical bearing rod ends present unusual freedom of movement, and provide greater carrying capacities, maximum misalignment, and longer life because of their ability to take greater radial and axial thrust loads. Outer casing of the bearing or bearing rod end is carbon steel, but is also available in Dural and other materials. The hardened and ground SAE 52100



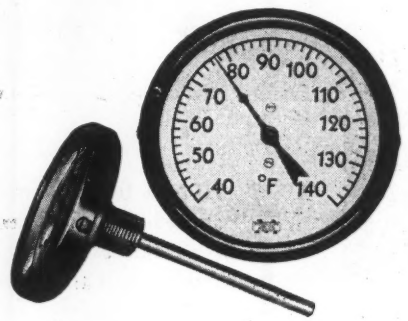
chrome steel ball inside the casing is ground as to width and drilled and finished ground to close tolerance for a wide range of shaft diameters. Bronze bearing inserts are expanded over the ball and into interlocking relationship with the outer casing. A groove is left between the halves of the inserts for oil or grease lubrication. Some of the applications of the rod end bearings include shoe machinery, electric fans, textile machinery, automobiles, washing machines, and machine tools.

Synthetic Aircraft Cowl Mountings

INSULATED AIRCRAFT cowl mountings impervious to oil, announced by Bushings Inc., 3442 West Eleven Mile Rd., Berkley, Mich., have a high rate of vibration and shock absorption, and a high resistance to heat. Bond between metal and synthetic is a mechanical rather than a chemical bond. Thus, heat does not affect mounting until temperatures beyond safe operation have been passed. The mechanical bond permits the use of virtually any combination of rubber or synthetic with such widely diversified materials as plastics, wood, steel, brass, powder bearing materials, etc.

Bimetal Dial Thermometers

BIMETAL DIAL thermometers in 2, 2½, 3½ and 4½-inch dial diameters are now being produced by Marshalltown Mfg. Co., Marshalltown, Ia. Providing a means of temperature indication of liquid or gas, these instruments are available in a variety of temperature



ranges. Standard scales are: —40 to 120 F; 20 to 240 F, 50 to 300 F, 50 to 400 F, 50 to 500 F, 60 to 220 F, 80 to 270 F, and 40 to 140 F. The thermometers feature direct and positive actuation with no gears or pinions. Dial of the instruments is white with black figuring, graduated for easy and accurate reading. They are encased in a flangeless drawn steel case and ring, black-enameled and oven-baked. Connections are for ¼-inch pipe thread for the smaller dial size, and ½-inch for the larger.

Chain Conveyor Lubricant

FOR HIGH-SPEED chain conveyors a new lubricant, developed by Turco Products Inc., 6135 South Central Ave., Los Angeles 1, provides good wetting action—one drop covering a large area with a thin and durable film. Marketed under the name of Botlube, it is nonstaining, soapless, noncorrosive and contains no oil. The lubricant is automatically dispensed through any simple container with a petcock and needle valve.

Nondeforming Flat Ground Stock

DEVELOPMENT of a nondeforming flat ground stock has been announced by Simonds Worden White Co., Dayton, O. For small machine parts, this steel known as "Air True" offers economy in time and cost on precision work eliminating more than 75 per cent of deformity, usually resulting from heat treating. Stock has black-oxide finish which inhibits rust and reduces friction on sliding surfaces.

Scrap Heap into "Treasure Trove"

How RADIOGRAPHY reclaimed $35,000 worth of castings from an $840 scrap pile

Almost as dramatic as a Yukon "gold strike," here's a case history of radiography speeding production . . . rescuing $35,000 worth of castings from the scrap pile . . .

Costly, complicated to cast, these 40-pound housings demanded—and received—the most precise casting technics. But in spite of all precautions, flaws were unavoidable . . . deliveries fell behind requirements.

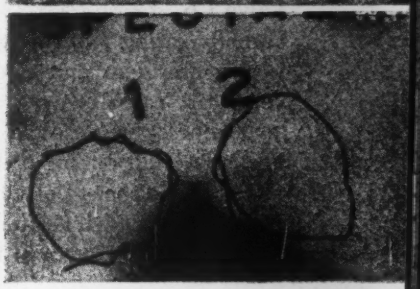
The suggested remedy was repair welds. But how could they be proved sound?

How? The foundry used radiography to locate the internal irregularities . . . then made the welded repairs and x-rayed them. Study of the new radiographs showed the repaired castings to be acceptable. The 350 castings which were thus salvaged each month brought deliveries up to schedule—with a monthly saving of thousands of dollars.

This case history—repeated in many industries—shows how radiography serves as a design and improvement tool . . . as well as an inspector. Tremendously increasing industrial output, under rigid inspection standards, radiography has more than "won its wings." Tomorrow, it will be an even greater *must*. Why not investigate its possibilities for you, *now?* See your local x-ray equipment dealer.

Investigation discloses irregularity. A flaw typical of those which slowed the foundry's deliveries on these complex housings.

Welding repairs the condition . . . BUT: Is the weld sound, is penetration satisfactory and metal well fused? Will the casting meet inspection requirements?



Radiography approves the repair: "Yes," says this radiograph—welding has made the rejected casting sound, sturdy, acceptable—and ready to use.

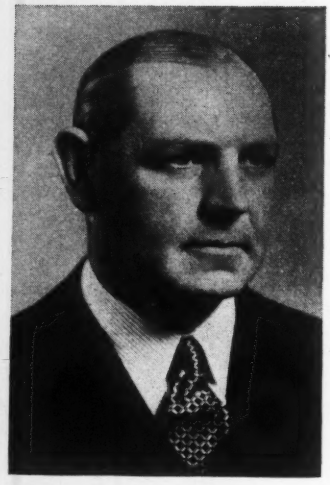
EASTMAN KODAK COMPANY, *X-ray Division,* Rochester 4, N. Y.

RADIOGRAPHY

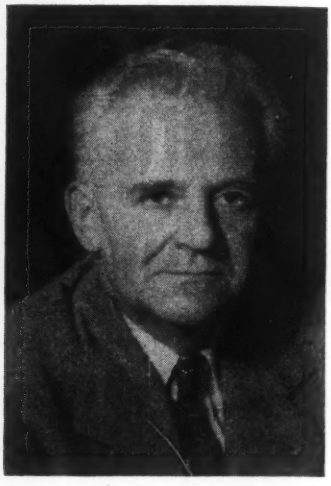
ANALYZES . . . INSTRUCTS . . . CORRECTS . . . IMPROVES

Kodak

D. Robert Yarnall



Hobart C. Ramsey



Walter Parrish

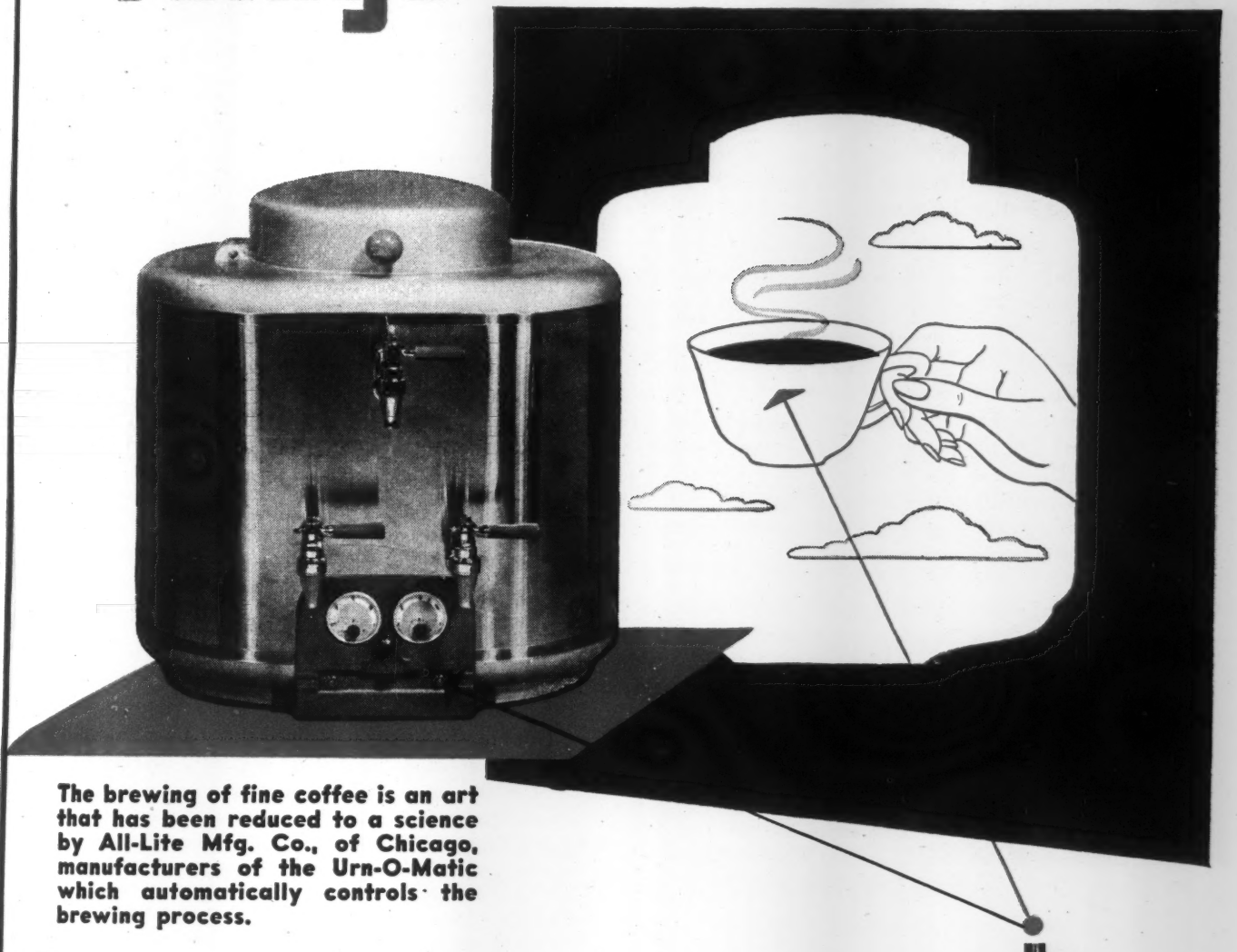
MEN...of...machines

D. ROBERT YARNALL, who for over a quarter of a century has been prominently and actively identified with engineering, has been nominated president of the American Society of Mechanical Engineers. Born in 1878 in Delaware County, Pa., he was graduated from the University of Pennsylvania in 1901 with the degree of bachelor of science in mechanical engineering. In 1905 he received the degree of mechanical engineer. He then went to work for Coatesville Boiler Works as engineer, and remained there for five years. His next position, also for five years, was with Stokes & Smith Co., in a similar capacity. From 1912 to 1918 he was vice president and general manager of Nelson Valve Co. During 1908, with B. G. Waring, he organized the firm of Yarnall-Waring Co., of which he is president at the present time. He is also president and director of James G. Biddle Co. For over forty years Mr. Yarnall's work at design and construction in conjunction with his business, has resulted in many patents on valves and steam specialties. He is an author of technical papers and has been active in many affairs of the society of which he has been nominated president. In 1941 he was awarded the Hoover Medal by the ASME and in the following year was made Doctor of Engineering by Lehigh university.

HOBART C. RAMSEY, executive vice president of Worthington Pump & Machinery Corp., has in addition to his present position been elected president of Ransome Machinery Co. Born in Chicago, Mr. Ramsey graduated from Annapolis, Class of 1915. He served in the first World War as Lieutenant Commander of the U. S. Navy. Following his resignation he joined the Worthington organization where subsequent experiences qualified him for a later promotion to vice president in charge of operations and most recently to president of the Worthington subsidiary, Ransome Machinery Co. In addition to his 25-year connection with the Worthington organization, Mr. Ramsey is well known for his many civic and professional activities.

WALTER PARRISH, who for the past five years has been executive engineer for the Superior Engine Division of the National Supply Co., has been appointed chief engineer of the Rogers Diesel and Aircraft Corp. In his new position he will take charge of the engineering, research and development facilities of the parent company, as well as aiding in the formulation of engineering plans for

how **relays** help to make coffee *Automatically*



The brewing of fine coffee is an art that has been reduced to a science by All-Lite Mfg. Co., of Chicago, manufacturers of the Urn-O-Matic which automatically controls the brewing process.

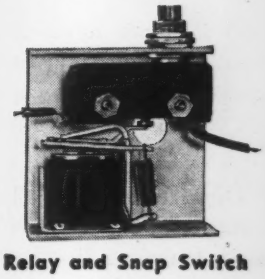
Relays BY GUARDIAN Control the Brewing Cycle

To make coffee by this method, the chef determines the amount of coffee desired and adjusts the dial accordingly then presses a push-button. This closes a snap-switch connected across the main circuit. When the predetermined amount of coffee is made a volume regulator actuates a Guardian relay mounted in combination with the snap-switch. An arm on the relay's armature returns the snap-switch to the "off" position and stops the brewing operation.

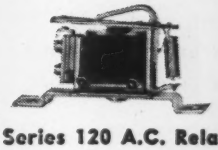
A simple application, yet one that calls for an accurate, dependable, sensitive relay. Operating on low voltage the relay must withstand jarring and heat, and possess high moisture resistance—specifications that you might ordinarily believe call for a specially built relay.

Actually the relay is Guardian's *standard* Series 120 with all the *standard* advantages of quick delivery, lower cost, available replacements.

Whether your application calls for a standard or a special relay, write us. Guardian engineers will recommend a unit most suitable to your needs.



Relay and Snap Switch



Series 120 A.C. Relay

GUARDIAN ELECTRIC

1601-M W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

the entire organization. He began obtaining experience for his present rich background in the automotive and diesel field in 1927, when he became associated with the Buda Co., first as assistant to the executive engineer and later as chief engineer for both gasoline and diesel engines. He also had charge of all the company's experimental and laboratory work. From 1938 he has been associated with such companies as the Caterpillar Tractor Co., Cummins Engine Co., Packard Motor Car Co., and the Continental Motor Co. in engineering capacities. He has been a member of the Society of Automotive Engineers since 1917, and recently was appointed vice president of the diesel engine activity for 1945, and a member of the National Council.

♦

HARRIS MCINTOSH has been named vice president in charge of engineering and production, Toledo Scale Co.

♦

DR. RUPEN EKSERGIAN, consulting engineer, Edward G. Budd Mfg. Co., Philadelphia, has been awarded the Louis E. Levy medal by Franklin institute, Philadelphia, for his paper entitled "On the Reaction of Fluids and Fluid Jets". He is well known in the fields of railway research on steam, diesel and lightweight trains, ordnance artillery design and development of generalized dynamic methods for machine analysis.

♦

GUSTAVE D. CERF has been made chief engineer of Edison-Splitdorf Corp. Division of Thomas A. Edison Inc.

♦

H. D. MATTHEWS, connected with the engineering department of W. M. Chace for more than ten years, has recently been named consulting engineer for the company.

♦

A. J. JEUDE recently has been appointed assistant to the chief engineer of Busch-Sulzer Bros. Diesel Engine Co., St. Louis. He had been a design engineer for the same company.

♦

WALTER L. DRAY, former liaison engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., is now assistant chief engineer of the aircraft armament engineering department of the same company.

♦

D. J. DESCHAMPS, widely known in the field of fuel injection as president of Deschamps Fuel Injection Corp., has joined American Bosch Corp., Springfield, Mass., as consulting engineer on gasoline injection. Mr. Deschamps had previously been very active in aircraft diesel engine development, and since 1935 has been associated with the design and development of gasoline injection equipment for aviation engines.

♦

RALPH S. WHITE has been made manager, engineering development, Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corp., Hagerstown, Md.

♦

S. W. SPARROW has been appointed director of research and development for The Studebaker Corp. Other engineering appointments by the company include that of E. M. DOUGLAS, executive engineer for manufacturing and service; H. E. CHURCHILL, chief research engineer and assistant to Mr. Sparrow; W. W. SMITH, executive engineer in charge of body design and development; and S. A. JEFFRIES, chief truck engineer.

♦

C. M. BOVARD has been promoted from chief draftsman to design engineer of Cooper-Bessemer Corp., Mount Vernon, O. RALPH H. SCHLOSSER becomes chief draftsman of the company.

♦

WALTER A. HURLEMAN has been appointed chief engineer, V. L. Graf Co., Detroit. He formerly had been assistant chief engineer, Jacobs Aircraft Engine Co., Pottstown, Pa.

♦

M. A. THORNE recently has been transferred back to the central engineering department, General Motors Corp., Detroit, following his completion of an assignment as chief engineer in the original design department, Fisher Tank Division, General Motors Corp.

♦

ARTHUR W. BENHAM JR. has become connected with American Airlines Inc., Long Island, N. Y., in an engineering capacity. He had been a field service engineer with Jacobs Aircraft Engine Co.

♦

ALBERT A. PREVOST, who had formerly been in the research division of the Mack Mfg. Corp., Plainfield, N. J., has joined the engineering department of the company, located in Allentown, Pa.

♦

CHARLES E. CREDE has joined the engineering staff of the L. N. Barry Co., Cambridge, Mass. Formerly he was supervisor of the shock and vibration division at the Naval Research Laboratories. Previous to that position, he was mechanical engineer on shock and vibration problems with the Bureau of Ships, Navy Department.

♦

JAMES L. RAY, well known steam and gas-turbine engineer, will head the gas and steam-turbine engineering department in San Francisco of Joshua Hendy Iron Works. Formerly Mr. Ray had been connected with Allis-Chalmers Mfg Co., as chief gas-turbine design engineer.

♦

JOHN G. WILLIAMS has recently become associated with the Cochrane Corp., Philadelphia. He had previously been mechanical development engineer.

♦

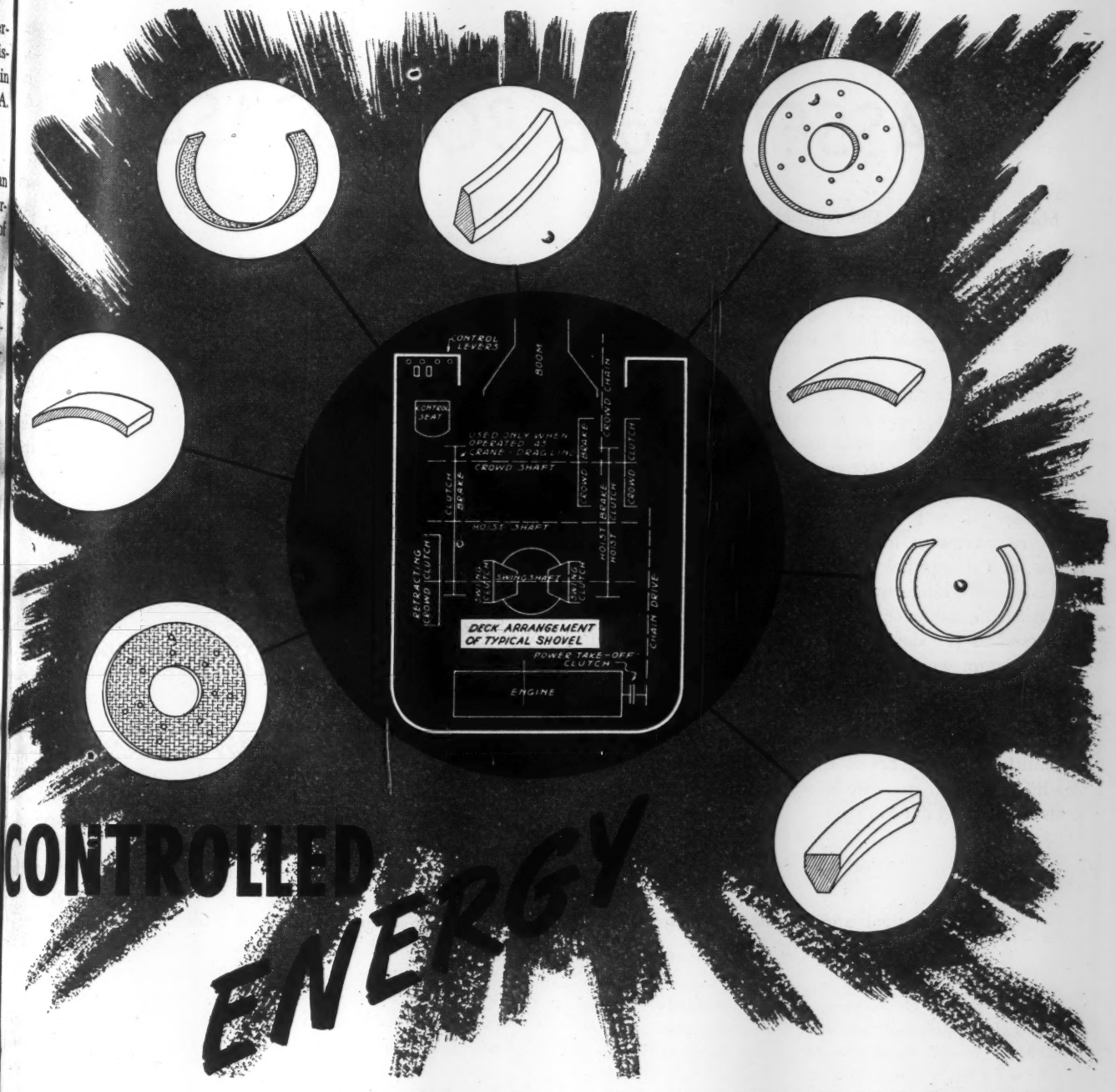
JOHN J. NARGI, who formerly owned his own firm, is now engineer in charge of engine development, Menasco Mfg. Co., Burbank, Calif.

♦

C. P. PESEK has been named administrator of engineering, Minnesota Mining & Mfg. Co., St. Paul. W. A. THOMAS, assistant chief engineer, has been made engineering consultant on Mr. Pesek's staff.

♦

C. V. BRINER, manager, gage and tool division, Pipe Machinery Co., Cleveland, is the new president of the American Society of Tool Engineers.



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ASSETS to a BOOKCASE

Manual on Design and Application of Leaf Springs

Published by the Society of Automotive Engineers Inc., New York; 37 pages, 8½ by 11 inches, paperbound, available through MACHINE DESIGN, *$1.00 postpaid to SAE members, $2.00 to nonmembers.*

A guide to designers of leaf spring installations, this new manual contains numerous figures, tables, and detailed calculations as well as data on spring materials, their surface finishes and protective coatings and manufacturing considerations. Covered in the text are general characteristics of leaf springs, nomenclature and specifications, requirements, drawings and tolerances, design elements, and design calculations.

Basic considerations of interleaf friction—a primary factor in the achievement of a successful leaf spring—are discussed as are design and operating stresses for attaining minimum weight and satisfactory operation. A chapter is devoted to the cold working of spring materials.

This manual was prepared under the direction of the SAE W.E.B. Spring Committee and the Leaf Spring Subcommittee. Engineers of these committees represent the leading vehicle manufacturers, spring suppliers, Army consultants and specialists.

□ □ □

Mathematical and Physical Principles Of Engineering Analysis

By Walter C. Johnson, associate professor of electrical engineering, Princeton University; published by McGraw-Hill Book Co. Inc., New York; 346 pages, 5¼ by 8¼ inches, clothbound; available through MACHINE DESIGN, *$3.00 postpaid.*

Based on a course in engineering analysis developed by the author over the past six years, this book presents the essential mathematical and physical principles of great import to engineers, especially those engaged in analytical work. Developed around practical information drawn from many divergent fields of engineering, problems mainly mechanical and electrical are presented emphasizing basic physical principles and physical reasoning.

The author devotes considerable attention to procedures in setting up equations, methods of attack, the use of assumptions, the use of mathematics for accurate and quantitative reasoning, and the physical interpretation of mathematical results. The conservation of energy, Newton's laws, d'Alembert's principle, conservation of momentum, principle of virtual displacement, Kirchhoff's laws, induced voltage, constant-flux linkages, and energy stored in inductive circuits are covered. A chapter of particular interest to engineers treats the checking of equations by dimensional and limiting-case methods of determination.

Mathematics presented is dealt with from a broad and unspecialized point of view to provide not merely another abstract and specialized tool but rather a key to help open the door to a clear and quantitative understanding of many important physical concepts and phenomena. This understanding attained, engineering problems and analyses can be handled the more intelligently and surely with highly accurate final solution.

□ □ □

Secrets of Industry

By Lewis C. Ord; published by Emerson Books, Inc., New York; 255 pages, 5 by 7⅜ inches, clothbound; available through MACHINE DESIGN, *$3.00 postpaid.*

Intimately interwoven into a history of world economic development over the past thirty or forty years is this story of the principles of true low-cost mass production. The author, an outstanding consulting engineer and mass production expert, makes a comprehensive and thorough study of industry, labor and management to emphasize the importance of industrial efficiency in successful achievement of real mass production.

Of tremendous interest to either engineer or executive concerned with mass output of any kind or variety of parts or machines, this book outlines in clear, concise form an overall analysis of the so-called "secrets" of industry. Manufacturing and marketing methods, not often apparent or available to the ordinary observer, discussed against a background of industrial experience in the United States, England, Canada, Europe, and Australia presents a new and vital story of sound, properly-implemented mass production, what its benefits can yield in prosperity for postwar America and ultimately the welfare of the whole world.

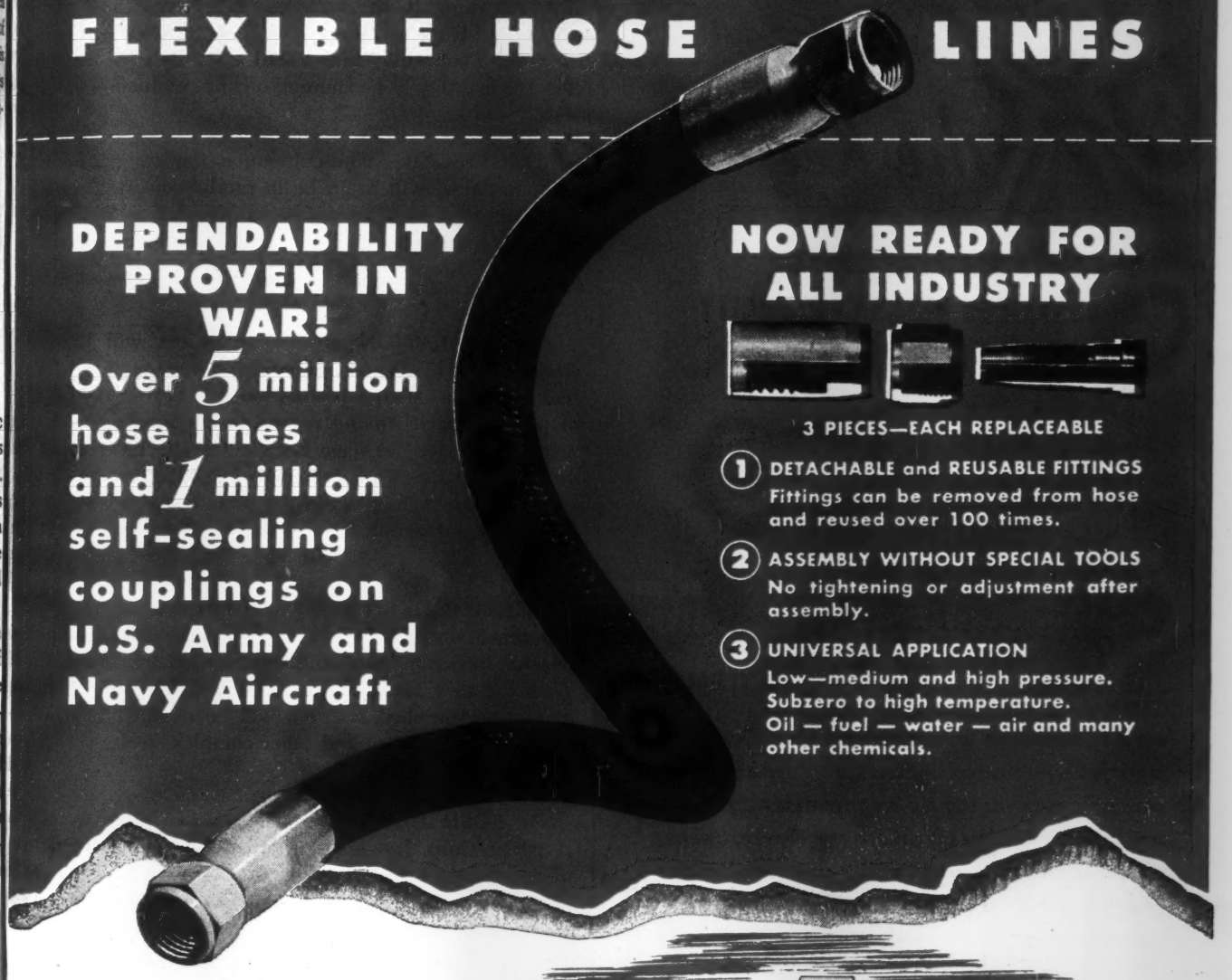
Practical Design for Arc Welding, Vol. III

Third and final volume of this interesting series brings to the designer in addition to further "idea stimulators" some valuable kinks on what not to do in designing for arc welding. Seeing firsthand some of the methods adopted in solving many complex design problems outlined by the author can be a great help to designers confronted with somewhat similar problems.

Presented by means of pictures and symbols as in the previous editions by author Robert E. Kinkead, consulting engineer on welding, the book is published by the Hobart Bros. Co., Troy, Ohio. Containing 100 design plates, 8½ by 11 inches, it is clothbound and is available from the Hobart Co. at $3.50.

Aeroquip

FLEXIBLE HOSE LINES



DEPENDABILITY PROVEN IN WAR!

Over 5 million hose lines and 1 million self-sealing couplings on U.S. Army and Navy Aircraft

NOW READY FOR ALL INDUSTRY

3 PIECES—EACH REPLACEABLE

1. DETACHABLE and REUSABLE FITTINGS
   Fittings can be removed from hose and reused over 100 times.
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   No tightening or adjustment after assembly.
3. UNIVERSAL APPLICATION
   Low—medium and high pressure.
   Subzero to high temperature.
   Oil — fuel — water — air and many other chemicals.

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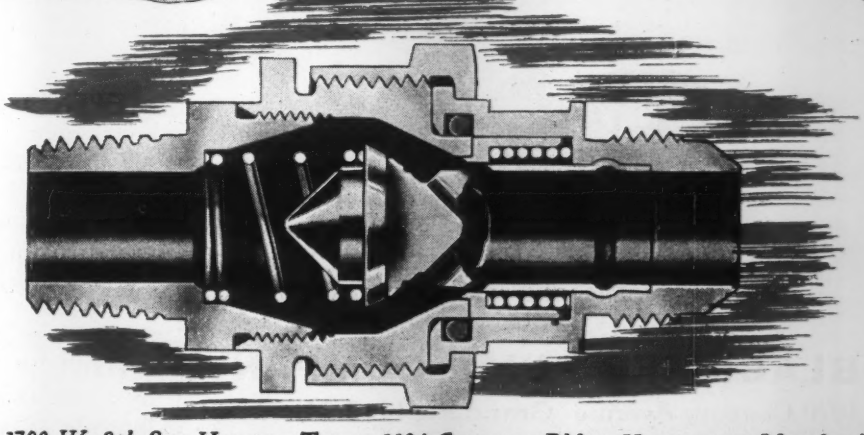
SELF-SEALING COUPLINGS

allow disconnection of liquid carrying lines without loss of fluid and reconnection without inclusion of air.



SALES OFFICES: *Los Angeles 14, California, 1709 W. 8th St.; Houston, Texas, 1104 Commerce Bldg.; Hagerstown, Maryland*

AEROQUIP CORPORATION, JACKSON, MICHIGAN, U.S.A.

BLACKMER PUMPS

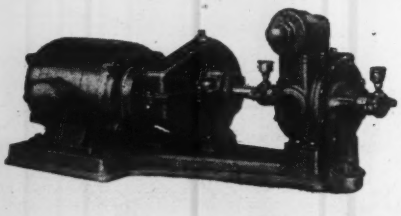
The Key to

- **LOWER PUMPING COSTS**
- **SUSTAINED PUMPING CAPACITY**
- **PUMP DEPENDABILITY**

Write for Bulletin No. 306

FACTS ABOUT ROTARY PUMPS

which explains why the "Bucket Design" (swinging vane principle) maintains pumping capacity by automatically compensating for wear and how the buckets, when finally worn out, are easily replaced and the pump restored to its normal capacity.



WE DESIGN AND BUILD SPECIAL PUMPS
OUR ENGINEERS ARE AT YOUR SERVICE

BLACKMER PUMP COMPANY
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POWER PUMPS · HAND PUMPS
· EZY-KLEEN STRAINERS ·

Transition Briefs

CONFIDENCE in the future of business is expressed by the oversubscription of $20,000,000 for the Kaiser and Frazer venture in the automotive field. To be built at Willow Run, the Frazer will be a medium-priced car and the Kaiser a low-priced car about the size of a Chevrolet. Both cars are expected to be in full production by March and, according to the builders, will have many modern mechanical features. Designs, however, will not be freakish; they will involve only time-tested units. By summer 20,000 cars per month will be running off the production lines.

ROTOTILLERS, land-cultivation implements built by Graham-Paige, will again be in production by December. Manufacturing facilities are being provided at Willow Run and the implements will be under production there by January.

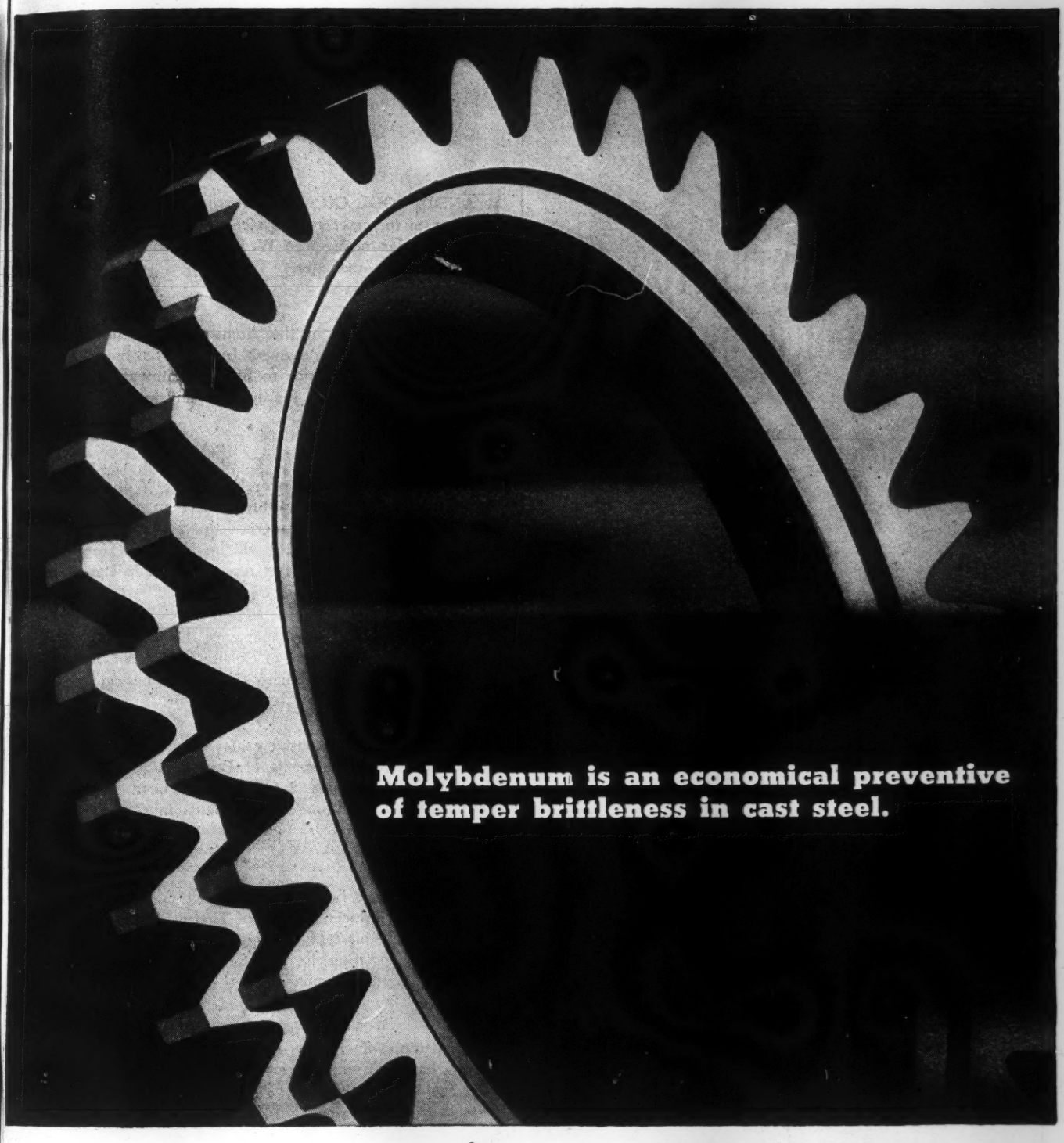
ACCUMULATION of civilian orders will keep the Package Machinery Co. at peak production levels for at least two years with a production staff almost double that of prewar years. Among recent design innovations in the company's machines have been automatic units which fill and seal 70 quart paperboard oil containers per minute and machines which wrap 7½-pound coal blocks at the rate of 24 per minute.

ULTRAMODERN $2,000,000 research laboratory and experimental center is part of the immediate peacetime expansion program of the Allegheny Ludlum Steel Corp. With the new facilities, an intensified program of fundamental and applied research will be devoted to stainless, magnetic, valve, tool and other complex steels.

DIVERSIFICATION and expansion program of the Aviation Corp. has taken another step in the acquisition of controlling interest in New Idea Inc., manufacturers of farm machinery and equipment. This follows the recent purchase of control of the Crosley Corp., makers of household appliances.

TWENTY YEARS of progress in research has been made by the plastics industry during the past five years. As a result there will probably be an increase in employment in returning to a peacetime basis. If the United Nations continue dismantling the German plants, American industry will strengthen world leadership and the fruits of our research will begin to appear.

POWDER METALLURGY applications will be served by a new consulting service announced by R. H. Khuen, formerly sales manager of Chrysler corporation's powder metal division. Better understanding of economies and special design features available with this technique will be promoted by the new organization.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

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Good news for designers, engineers, manufacturers, dealers and users alike. It means you can have — not "just gasoline engines" — but Briggs & Stratton "Air-Cooled Power."

Precision manufacture and constant advancements in design and engineering account for the brilliant record of well over 2-¼ Million of these trouble-free 4-cycle gasoline engines during 26 years of continuous production. Only by specifying Briggs & Stratton "Air-Cooled Power" can you get all of the advantages which have earned for Briggs & Stratton unquestioned leadership as manufacturers of "the world's finest gasoline engines."

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wisconsin, U. S. A.

Air-Cooled Power

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

BUSINESS AND SALES BRIEFS

LANDIS TOOL CO., Waynesboro, Pa., has promoted R. F. Ingram to secretary and vice president. He is succeeded as general sales manager by W. P. Lotz, who previously served as eastern sales manager.

♦

With headquarters in the Architects & Builders building, Joseph Edie has been named Indianapolis branch manager of Jessop Steel Co. Prior to his appointment Mr. Edie had been sales representative for the company in Cleveland.

♦

Establishment of a West Coast plant at LaVerne, Calif., has been announced by Taylor Fibre Co. William Rose, connected with the company for more than twenty-five years, will be in charge as manager of the new plant. Associated with him in a sales capacity will be Edgar B. Howard Jr., at present serving as West Coast representative in Los Angeles.

♦

Formerly general sales manager, Edward W. Ward has been elected vice president of Celanese Plastics Corp., a wholly owned subsidiary of Celanese Corp. of America.

♦

Transfer of the executive, sales, engineering, procurement and accounting departments of Lear Inc. to 110 Ionia Ave., N. W., Grand Rapids 2, Mich., has been made recently. Production will continue at the plants in Grand Rapids, and in Piqua, O.

♦

Oscar Nuss has been named district manager of the Industrial Rubber Products Division of Thermoid Co., Trenton, N. J., and will make his headquarters at the plant in Los Angeles. In his new position he will serve the southern California, New Mexico and Arizona areas.

♦

Acquisition of a new factory building at West Warren, Mass., has been announced by Teckna Co., Bayside, N. Y. The factory will be used for the finishing of cast resins as well as thermoplastics.

♦

Previously associated with the Bullard Co., Robert H. Boyer has been appointed sales engineer of The Osborn Mfg. Co., Cleveland.

♦

Steps have been taken by Square D Co. to double the size of the present plant in Milwaukee. As soon as plans are completed, construction can begin on the large tract of land already owned by the company which is immediately adjacent to the plant.

♦

Opening of a West Coast office at 5607 West Adams Blvd., Los Angeles, has been announced by Robert Hetherington & Son Inc. of Sharon Hill, Pa. Sales will be under the direction

Prevent Failure

OF CRITICAL PARTS

with Surface-Hardened STAINLESS

No chances can be taken that critical parts will fail in life-saving equipment like this aircraft crash truck. When in operation the nozzle must move freely and easily so that the operator can "sweep" the flaming gasoline away from the trapped flyers with the high-pressure water stream.

Even under the terrific force developed by the high-velocity jet, the bearings in the swivel joints of the nozzle must not bind or seize. And of course there must be no rust or corrosion to impede the smooth action of these bearings.

That is why Samuel Eastman Company installs bearings of Surface-Hardened Stainless Steel in the swivel joints of the nozzle.

With the new Surface-Hardening Process (Malcomizing), it is now possible to take advantage of the inherent strength and corrosion-resistance of stainless steel, and at the same time to get wear-resistant surfaces as hard as 95 Rockwell 15N (73 Rc).

Wherever remarkable ability to stand up under abrasive wear, combined with resistance to heat, corrosion, and oxidation will prevent failure of critical parts, you should consider the Stainless Surface-Hardening Process.

For More Information

If you want to know more about the advantages of this new process and how you can use it, write for the technical bulletin. If you wish, one of our metallurgical engineers will discuss it with you.

JLMCo CS-L1

SS HC

STAINLESS SURFACE HARDENING CO.

263 BENT STREET • CAMBRIDGE 41 • MASSACHUSETTS

SUBSIDIARY OF INDUSTRIAL STEELS, INC.

America's Largest Warehouse for Stainless Sheets, Bars, Tubings, Wire, Valves, Fittings, Electrodes and Hardware

OHIO

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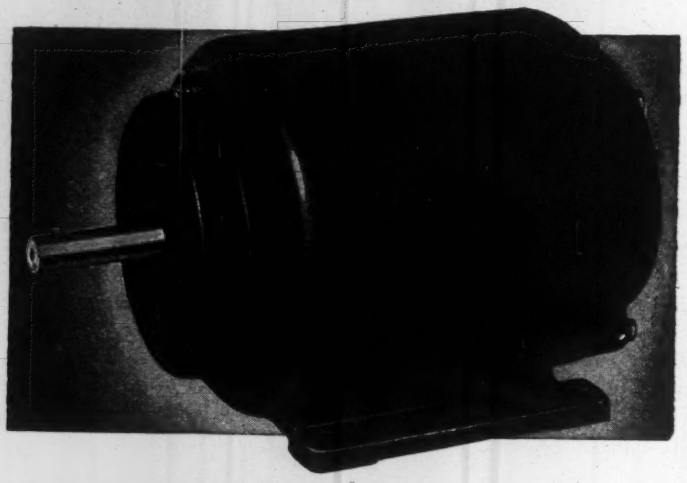
INTEGRAL MOTORS



Type P-2 or 3 Phase, 60 cycle
Voltages—110, 220, 440 and 550
Squirrel Cage Rotor, dynamically balanced
Normal torque; Constant speed; Ball bearing; Fully enclosed;
Plain barrel frame or rigid base for Floor; Sidewall or Ceiling mounting.

Sizes—½-¾ and 1 HP at 850 RPM
¾-1 and 1½ HP at 1150 RPM
1-1½ and 2 HP at 1750 RPM
1-1½ and 2 HP at 3500 RPM

Same sizes 50 cycle at 5/6 of above speeds. Odd voltages and cycles available. Shaft length and lead outlet to suit. A quiet running motor with minimum vibration.

OHIO MOTORS INCLUDE

Split-phase Induction to 1/3 HP	Torque to 100 oz. ft.
Direct Current to 1 HP	Shaded Pole to 1/30 HP
Capacitor to 2 HP	Synchronous to 1/4 HP
Polyphase to 2 HP	A.C. to D.C. Motor Generators to 500 watts
Aircraft Motors	High to Low Voltage D.C.
Shell Type to 7½ HP	Dynamotors up to 300 watts

What is your problem?

THE OHIO ELECTRIC MFG. CO.

5906 Maurice Avenue **Cleveland, Ohio**

of C. E. Fisher, formerly connected for fifteen years with Glenn L. Martin Co. of Baltimore, Md., but most recently engaged in sales work on the West Coast, while engineering will be under the direction of L. E. Massie who will operate from the new office.

♦

Associated with the company for over ten years, Walter B. Chick has been appointed district manager in the northwest Pacific Coast area of the Industrial Rubber Products Division of Thermoid Co., Trenton, N. J. Mr. Chick will be located at the San Francisco branch office, 895 O'Farrell St.

♦

Recently announced by The Foxboro Co. is the addition of Clarence Leslie Williams to the New York staff of sales engineers at 420 Lexington Ave. Mr. Williams has been assigned to cover the northern New Jersey territory.

♦

Acquisition of a 29 acre industrial tract on the East Waterway, Seattle, Wash., has been made by Monsanto Chemical Co. through its Seattle subsidiary, I. F. Laucks Inc. A new modern plywood adhesives plant will be erected.

♦

Opening of a direct factory branch sales office at 4427 Manchester Ave., St. Louis, has been announced by The Lincoln Electric Co. The new branch will be under the direction of B. J. Brugge, welding engineer and district manager of sales and service, who has been connected with the company since 1931.

♦

With headquarters at St. Louis, Frank C. Cline has succeeded Dan M. Galvin as acting manager of the Southwestern district of Westinghouse Lamp Division, which includes Missouri, Kansas, Colorado, Texas, Oklahoma, Arkansas, New Mexico, and parts of Wyoming, Mississippi, Tennessee, South Dakota and Illinois. Succeeding Mr. Cline is George S. Crawford as special representative in the Northwestern district, with headquarters at Chicago.

♦

Establishment of a subdivision devoted exclusively to precision casting of small intricate parts has been announced by The Cooper Alloy Foundry Co. Located at 123 Van Buren St., Newark, N. J., the new division is known as Precise Castings Corp.

♦

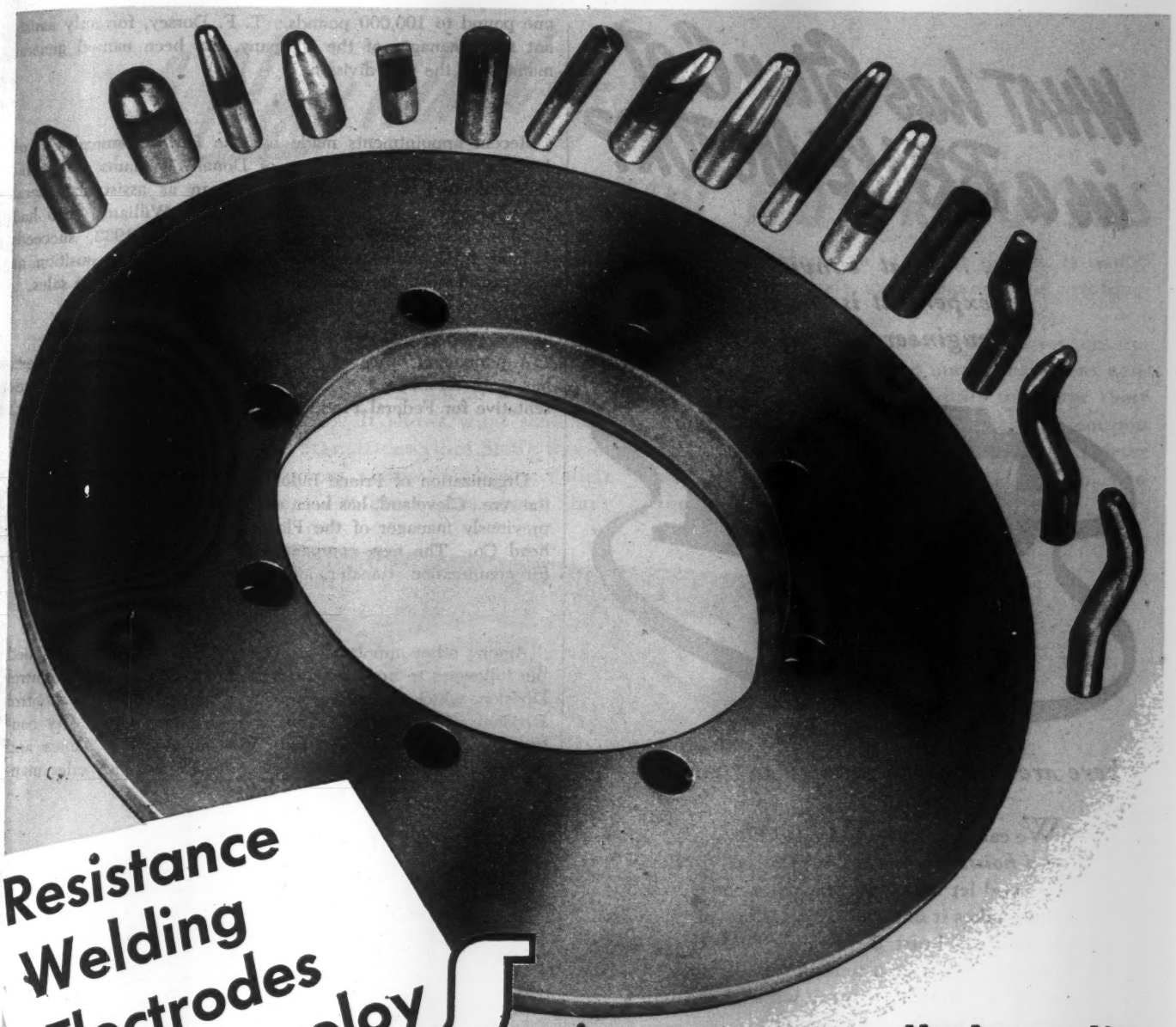
Made known recently by Bearing Products Co. of Philadelphia is the purchase of the line known as R-S standard bearing covers from R-S Products Corp.

♦

Formerly president and general manager of Hydraulic Press Mfg. Co., Howard F. MacMillin has joined the industrial research organization of Arthur D. Little Inc., Cambridge, Mass. He will direct the application to industry of developments made by the company in the mechanical engineering and applied physics fields.

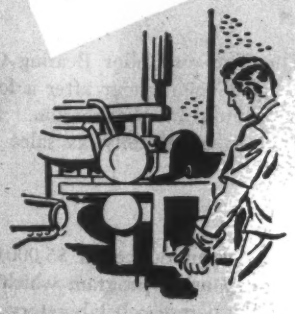
♦

Purchase of the plant and equipment of Fort Pitt Steel Casting Co., located at McKeesport, has been announced by Pittsburgh Steel Foundry Corp., Glassport, Pa. Known as the Fort Pitt Division, the foundry will specialize in the production of small carbon and alloy steel castings, ranging from



Resistance Welding Electrodes of Ampcoloy

give you controlled quality and uniformity . . . eliminating costly production losses



Specialists in engineering, production, and finishing of copper-base alloy parts.

In resistance welding, lack of uniformity in electrodes and wheels means "time out" to adjust current, time, and pressure settings—resulting in costly production losses.

At Ampco, control of quality and uniformity — both absolutely necessary in this exacting field — are kept under close supervision of laboratory technicians throughout the entire production cycle, resulting in increased productive time.

Ampco resistance welding products comply with all RWMA specifications. Included in the line are spot welding electrodes; seam welding wheels; centrifugally cast seam welder bushings; seam welder shafts; flash and projection welder dies; extruded and drawn rounds; and many others.

To reduce your welding costs, standardize on Ampco's line of resistance welding electrodes. You are assured of all-important uniformity . . . *consistently*. You cut "down-time" to a minimum . . . you speed production — and, finally, you get more service from each electrode. Complete details are given in Bulletin 68. Write for your copy. Your request will receive prompt attention.

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RW-2

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. . . that convinces many experts it is the finest ever engineered?

Specially designed Star Brake Motor for elevator duty on LST vessels.

There are two ways to answer that one . . .

We can give you a long list of makers of *cranes and hoists* who have used the Star Brake Motor . . . and let them tell you what there is about it that makes it so good . . . why they prefer STAR. Crane and hoist duty really tests out a brake motor! Name your field, if you'd prefer to check another – Star Motors are widely used whenever service is tough.

Or, we can give you the details about the Integral Disc Brake which Star designed and perfected. You'll see why this Brake is noted for *sureness* in operation . . . why it stays accurate and effective, *without adjustment* . . . why it leads to compact design.

There are plenty of superior features that you should know about before you pick a Brake Motor for your product or your production line. Write us for the facts. Star Electric Motor Co., 200 Bloomfield Ave., Bloomfield, N. J.

STAR MOTORS

POWER PACKAGED AS YOU NEED IT

one pound to 100,000 pounds. T. F. Dorsey, formerly assistant sales manager of the company, has been named general manager of the new division.

♦

Recent appointments made by The Dow Chemical Co. of Midland, Mich., include those of Donald Williams as general sales manager and Donald K. Ballman as assistant general sales manager. In his new position Mr. Williams, who had been assistant general sales manager since 1933, succeeds Leland I. Doan. Mr. Doan, in addition to his position as vice president of the company, has become director of sales.

♦

A permanent office at 718 Leeland Ave., Houston 2, Tex., has been established by E. L. Stacey, southern Texas representative for Federal Products Corp.

♦

Organization of Prince Industrial Plastics Corp., 7500 Stanton Ave., Cleveland, has been announced by Warren V. Prince, previously manager of the Plastics Division of The Weatherhead Co. The new company will design and produce parts for compression, transfer, and injection molding.

♦

Among other appointments General Electric Co. has named the following to head newly organized sections in the Control Division, which formerly was known as the Industrial Control Division: William M. Anthony, sales manager, industry control section; Edward S. Bush, sales manager, appliance and aircraft control section; and S. V. W. Dockstader, sales manager, general purpose control section.

♦

Previously chief materials engineer with Carl L. Norden Inc., U. R. Jaeger has been made sales engineer in the New York district of the Industrial Division of Aluminum Industries Inc., Cincinnati, O. He will make his headquarters in the New York sales office, 9 Rockefeller Plaza.

♦

Appointment of Franklin P. Clark as sales manager has been announced by The Upson-Walton Co. of Cleveland, manufacturer of wire rope, fittings, etc. Recently with the Navy Bureau of Supplies and Accounts, he formerly had been associated with The Jones & Laughlin Steel Corp. of Pittsburgh.

♦

Recently made known by The Timken Roller Bearing Co., Canton, O., is the return of L. H. Gegenheimer after a four-year leave of absence for war duties in Washington. Mr. Gegenheimer will serve in his former capacity as sales engineer in the Industrial Division.

♦

Allegheny Ludlum Steel Corp. has announced a $5,000,000 postwar research and production expansion program which includes construction of an ultra-modern research laboratory and related experimental and pilot plant equipment at company headquarters at Brackenridge, Pa., and construction of a cold rolling mill for rolling stainless and silicon strip steels, at West Leechburg, Pa.

♦

With offices at 2450 Hubbard St., M. N. Weber has been named Detroit sales representative for Trimount Instrument Co., Chicago. He had been connected with the research

A New kind of

DIGEST FOR MOTOR BUYERS

IT'S DIFFERENT because it doesn't attempt to give you a lot of general technical data about motors and motor selection.

This eight-page file-size folder assumes that you know what type of motor you need. It was designed to tell you, quickly, about STAR as a source of motors and generators. It shows what sizes and types are built by Star. It describes Star's way of working with customers . . . how Star becomes their "Motor Department". It gives facts about Star's pioneer achievements in motor design. It names many hard-to-satisfy motor buyers who are long-time customers.

To bring your file on leading motor sources up-to-date . . . to learn why so many prominent concerns are turning to Star Motors to power their products and production . . . attach the coupon below to your letterhead. It will also register you to receive the Complete Catalog which is in preparation.

STAR MOTORS

POWER PACKAGED AS YOU NEED IT

STAR ELECTRIC MOTOR CO.,
220 Bloomfield Avenue
Bloomfield, N. J.

☐ Send 8-page bulletin about Star Motors

☐ Put me on list to receive Complete Catalog

Name and position.....

Company.....

Address.....

.....

laboratories of Continental Aviation & Engineering Corp., Detroit. M. S. Jacobs, formerly instrument engineer for The Koppers Co., Pittsburgh, has been chosen sales representative for Trimount in the Pittsburgh area, and will make his headquarters in the Bessemer building.

♦

According to a recent announcement by United States Gauge Co., W. S. O'Connor has been promoted to national field sales manager and will assist L. L. Corcoran, sales manager. Succeeding Mr. O'Connor is H. M. Bear as district manager of the sales territory covered by the New York office.

♦

To serve as its representative in Oklahoma, southern Kansas and southwestern Missouri, Ampco Metal Inc. has appointed N. A. Doolittle, 1850 East 16th Place, Tulsa, Okla. He will handle the sale of castings and other bronze specialties of the company. A number of counties in southeastern Texas have been assigned to W. W. Swan, Carondelet building, New Orleans, La., in addition to the states of Louisiana, Alabama and Mississippi which he has been covering.

Meetings and Expositions

Nov. 16-17—
National Metal Trades association. Forty-sixth annual convention to be held at Hotel Cleveland, Cleveland. Charles L. Blatchford, 122 South Michigan Ave., Chicago 3, is secretary.

Dec. 3-5—
Society of Automotive Engineers Inc. National air transport engineering meeting to be held at Edgewater Beach Hotel, Chicago. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Dec. 16-19—
American Institute of Chemical Engineers. Thirty-eighth annual meeting to be held at Stevens hotel, Chicago. S. L. Tyler, 50 East 41st St., New York 17, is executive secretary.

Jan. 7-11—
Society of Automotive Engineers Inc. Annual meeting and engineering display to be held at Book-Cadillac hotel, Detroit. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Jan. 21-25—
American Institute of Electrical Engineers. Winter convention to be held in New York, N. Y. Additional information may be obtained from headquarters of the Society at 33 West 39th St., New York 18. H. H. Henline is secretary.

Feb. 4-7—
American Welding Society. National meeting to be held in conjunction with the National Metal congress and exposition to be held at Public Auditorium, Cleveland. Headquarters will be at Hotel Cleveland. M. M. Kelly, 33 West 39th St., New York, is secretary.

Feb. 4-8—
American Institute of Mining and Metallurgical Engineers. National meeting of the Iron and Steel, and Institute of Metals divisions to be held in conjunction with the National Metal congress and exposition, Public Auditorium, Cleveland. Headquarters will be at Hotel Statler. Frank T. Sisco, 29 West 39th St., New York, is assistant secretary.

Feb. 4-8—
American Society for Metals. Postponed 1945 annual convention to be held in conjunction with the National Metal congress and exposition, Public Auditorium, Cleveland. Headquarters will be at Hotel Statler. W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, is secretary.

Feb. 6-8—
American Industrial Radium and X-Ray society. Annual convention to be held in conjunction with the National Metal congress and exposition, Public Auditorium, Cleveland. Headquarters will be at Hollenden hotel. Phillip D. Johnson, 25 East Washington St., Chicago, is secretary.

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